POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
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Volume 72 NEW YORK, DECEMBER 2, 1930 *Number 23*

Modernize the Personnel as Well as the Plant

MUCH STRESS has been put, and rightly so, upon the importance of maintaining efficiency in the processes of production.

Large savings in the cost of the power which enters into the cost of all products have been made and many more are possible through the use of modern methods and machinery and the rehabilitation of obsolete and wasteful plants.

There is an equal chance for saving in the employment of a better type and quality of man to operate them.

Some men are like the old-fashioned slow-running low-pressure plants that they have grown up with. They accept the outfit as they found it, go through the motions of running it as they learned them and reach the limit of their capabilities and interest when they keep it going.

Others, with knowledge of the possibilities and an appreciation of their failure to realize them, hunt out sources of waste and opportunities for improvement, get the most out of existing equipment and make intelligent suggestions for revision.

A consulting engineer told me recently of an instance where the change from a $2,500 to a $4,000 man resulted in a saving of some $40,000 per year.

A real engineer may be able to make as satisfactory a percentage of saving with an existing plant as would modernization of the plant itself; but the best combination, of course, is that of a plant adapted to the work and an engineer who knows how to get the most out of it.

There are still, unfortunately, a lot of executives who have not got beyond the conception of the power plant engineer as a simple mechanic, smudged with the grease and grime of the old-fashioned engine and boiler room. If he has ideas, the executives are inaccessible to him, or if he gets to them they have seen him in his working clothes and give him slight consideration, especially if his suggestions involve additional investment.

However thoroughly and honestly a machine may be made, however intelligently adapted to its service, however carefully used and maintained, it will sooner or later become obsolete. However good it may still be as a mechanism, you cannot change its type or make it over to suit altered conditions.

Men, on the other hand, need not become obsolete. If they have the ambition and interest and mental and physical qualifications they can keep themselves up to and ahead of the requirements and opportunities of their positions

The modern power plant, with its multiplicity of services, its complication and the opportunities that it affords for saving, in efficiency of service as well as in fuel, demands a responsible head of the executive engineering rather than of the manual mechanic type. The employment and recognition of such men and encouragement in carrying out their ideas would result in vast savings in the power account of the industries.

F. R. Low

EDITORIALS

New York Submetering In Way of Progress

STRIPPED of its legal furbishings, the fight of the New York Edison Company and affiliates to reduce its rates resolves into the question of whether the submetering companies and real estate operators shall be permitted to continue to collect their "squeeze." In the process of determining this, those who sit on the bleachers see the spectacle of a public utility group struggling to reduce its distribution cost, to the benefit of the consumer; meanwhile a recent election throughout many states points to dissatisfaction with the established order of utility operation, in which high rates are involved.

Apparently, the real estate operators and submetering companies seek to perpetuate the very thing for which the utilities are being condemned.

While it is natural enough for these two groups to endeavor to preserve one of their sources of revenue, they are distinctly out of step with the times. The old system has served its period of usefulness and the spirit of the present must prevail. It is contrary to economics to stand between the utility and the consumer and so obstruct the effort to reduce the ultimate price of power.

If lower electricity cost to the consumer means the difference between profit and loss to the real estate operator, their relief is in readjustment within their own sphere. Moreover, the submetering companies must face the discontinuance of their businesses in the interest of lower prices to the consumer.

The traffic just won't carry the load much longer.

Boiler Evolution

RECENT YEARS have seen the rapid evolution of boiler furnaces into entirely new types distinguished chiefly by the use of water walls, or combinations of refractory and water walls. Certain trends point to possible changes, equally fundamental, in the general arrangement of heating surface.

One trend is found in the new plants employing 1,400-lb. steam pressure, where economizer, reheater and air heater have grown until they almost dwarf the boiler itself. An outstanding example is the recently completed Gilbert station (formerly called Holland), in which each steam-generating unit has but 7,980 sq.ft. of water-evaporating surface. Rated by the obsolete "boiler-horsepower" yardstick, this is a "798-hp." unit, although it supplies steam to generate 27,500 kw. In this installation, the boiler represents but 12 per cent of the total heating surface. The superheater accounts for 6.9 per cent; gas reheater, 17.2 per cent; economizer, 17.6 per cent; and air preheater, 46.3 per cent.

These astonishing proportions are explained in part by the comparative cost of high-pressure boilers, which suggests transfer of heating surface from boiler to economizer and air heater. Making allowances for some reaction when lower boiler costs arrive, and for the fact that a square foot of air-heating surface cannot properly be compared directly with a square foot of boiler surface, the change is still significant.

An entirely different trend is exemplified by the Loeffler boiler, which replaces water-heating surface by a huge superheater, followed by an economizer. The Loeffler system of steam generation removes the boiling operation from the "boiler" to a detached drum in which superheated steam bubbles through water to produce more steam.

A multiple-superheater boiler unit, in which some water-heating surface is replaced by a primary superheater, was described by K. Baumann in a recent paper before the Institution of Mechanical Engineers (Great Britain), Northwestern Branch. This unit eliminates all water-evaporating surface except the furnace water walls. Steam from the first superheater is passed through a desuperheater, where it generates additional saturated steam. This, with the partly desuperheated primary steam, is reheated in a second superheater. Close control of superheat temperature, rather than increased boiler-unit efficiency, is the purpose of this arrangement.

These examples are presented not to prove that any particular trend will continue, but to show that many factors are at work to alter the design and arrangement of heating surface in boiler units.

Apply Prevention to Low Power Factor

SUGGESTIONS for power-factor improvement may be divided into preventive and corrective measures. The ease with which the latter can be applied should not be an excuse for neglecting the economic possibilities of the former. Overmotoring is a major cause of low power factor. Induction motors too large for the load cost more than those of correct size and have a low power factor, and in many cases the investment has to be further increased by purchasing power-factor corrective equipment.

Synchronous and other high-power-factor motors have been developed to where they are interchangeable with general-purpose induction motors. Their intelligent use offers opportunities of preventing low power factor. Slow-speed synchronous motors cost less and have higher efficiency than induction motors of corresponding size and speed. In addition, their power factor can be controlled; while that of induction motors is of a low lagging value. Where corrective capacity is necessary, it is frequently most economically provided in synchronous motors oversize for their loads.

For certain applications motors cannot always be kept loaded even when of correct size. They may operate lightly loaded a large part of the time and be overloaded during certain periods. Such applications will have a low power factor. Where they constitute a considerable part of the load, corrective equipment will be required.

Both preventive and corrective means have their place in the power-factor problem, but the latter should be applied only when the desired result cannot be attained by the former.

Hydrogen-Cooled Generators

FOR several years manufacturers of large turbine-generators have been experimenting with gases other than air for cooling. Of many gases tried, hydrogen has proved superior. A number of hydrogen-cooled synchronous condensers are in operation and have shown the practicability of this method. With these machines, such cooling is comparatively simple, since they may be inclosed in gas-tight shells and installed outdoors. On generators, the rotor shaft ends project through the casing, hence seals are required to prevent gas leakage along the shaft. This problem has now been solved and the first hydrogen-cooled generator has been in service for several months.

Explosion hazards are usually associated with the use of hydrogen. These, however, are not so real as one might expect. Hydrogen and air in certain proportions only form explosive mixtures and these proportions are not present in hydrogen-cooled machines. Even an arc from a winding failure cannot cause an explosion or a fire in the machine, because of insufficient oxygen to support combustion. Control and safety devices have been provided that make such machines as safe as those using the conventional ventilating systems.

Because of hydrogen's better thermal characteristics, a machine thus cooled has at least twenty-five per cent greater capacity than with air cooling. This is one of the most important advantages in using hydrogen. Also, high-voltage generators cooled with air require careful design and manufacture to prevent corona attacking the insulation and causing failures. This problem has been intensified by the increases in generator voltages now in use. In a hydrogen atmosphere, corona has little if any effect. Therefore, generator designers are finding in hydrogen a means of removing a limitation that they have been rapidly approaching.

Stokers And High Preheat

MUCH DISCUSSION has followed the wide distribution of a statement that stokers of the multiple-retort underfeed type have distinct limitations when operated with preheated air in excess of 250 degrees Fahrenheit.

A check-up on present practice shows a number of plants to be operating satisfactorily at 400 to 500 degrees; others are carrying 300 to 400 degrees; while on the other hand, some have found a lower preheat better suited to their conditions. This is true especially where coal of low ash-fusing temperature is burned. Moreover in plants where economizers and air preheaters are installed in series the preheat is necessarily lower.

Some of the earlier attempts to employ high preheat led to excessive stoker maintenance. This was met by modifications in structural details, by changing the fuel, or by lowering the preheat. To what extent these may be regarded as limitations depends upon local conditions. The essential fact is that some plants are employing 400 to 500 degrees or over, and if a greatly higher temperature were desired, stoker experience is now such that material and structural refinements could undoubtedly be employed to meet it, providing the coal is suitable.

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POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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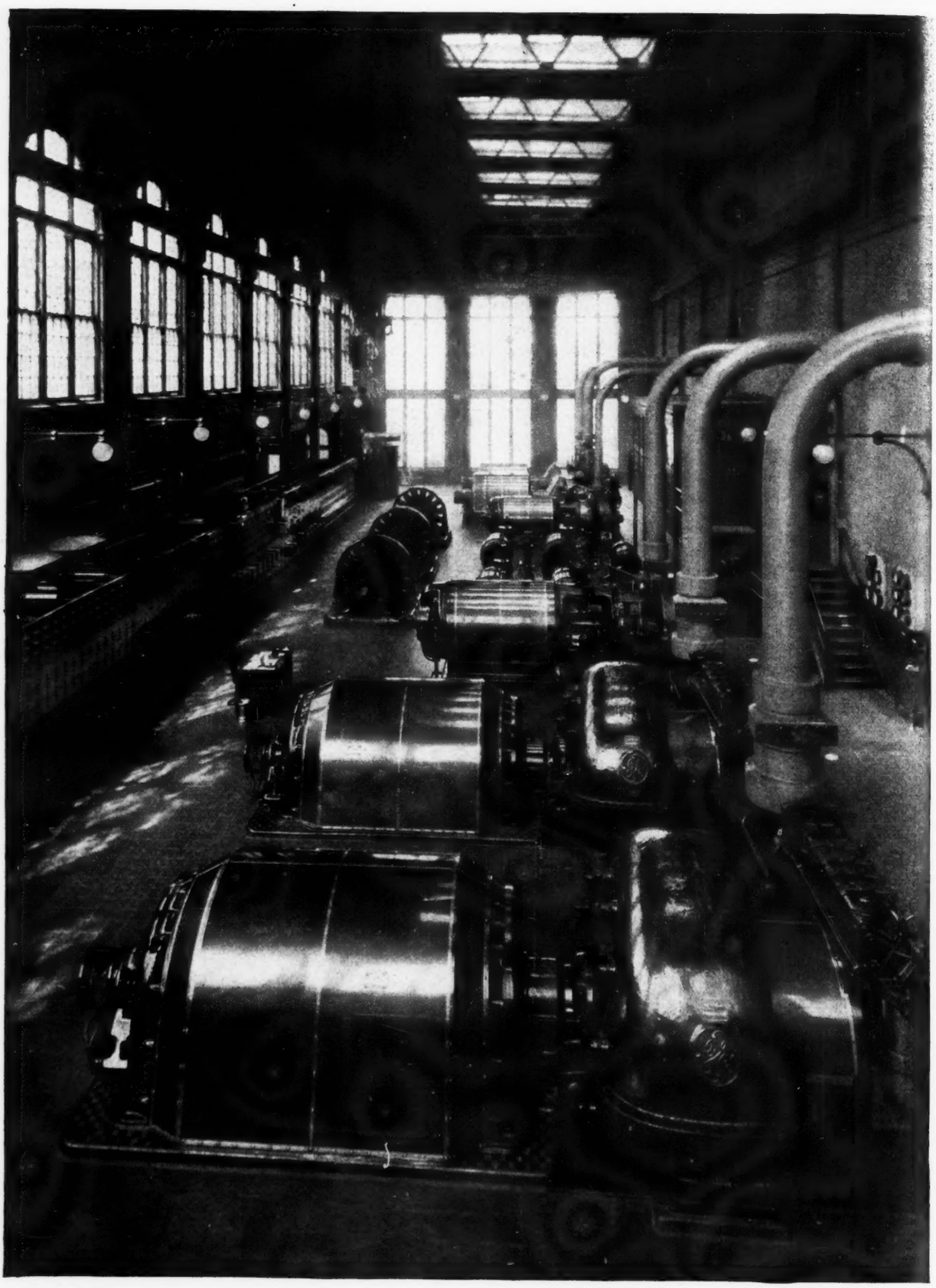


Turbine Room at Hawthorne

In the foreground are the recently installed 7,500-kw., 12,000-volt turbine-generators. At the left is the combined high- and low-voltage control board, with one of the tie-in transformers shown in the far background.

Western Electric Remodels Power Plant at Hawthorne Works

By C. B. BARNES
Superintendent of Plant Engineering
Hawthorne Works

The summary of a six-year revamping program. A feature of the new plant is the installation of the largest cooling towers in America. Airplane propeller-type forced-draft fans are employed

IN 1927, twenty-three years after the initial power plant at Hawthorne was planned, it became necessary to increase the power facilities. In a six-year program, it was estimated that provisions for about double the then existing electric and steam load should be made. The increased use of electrically heated furnaces and processes, many improvements in manufacturing operations, and the growth of the manufacturing plant in general, had resulted in a demand for power that could not have been foreseen by the engineers in laying out the initial plant. Thus the space available for drawing armatures and shafts limited the selection of turbine-generators; the arrangement of condensing equipment was affected by the existing basement layout; and the height of the boiler house and the spacing of building columns affected the boiler capacity that could be put into the available area. The improved economies and design of power plant equipment and the changes and advancement in manufacturing methods and processes had so readjusted the proportionate demand for the various services—gas, steam, electricity and compressed air—as to alter materially the balance of load in the power plant.

An analysis was made of the comparative cost of providing both steam and electric power, or purchasing electric current and providing in the local plant steam only for manufacturing processes and steam-using auxiliaries. It was found that it would be more advantageous and economical to generate all the steam and electric power required, inasmuch as a good portion of the steam produced is required for manufacturing processes and heating, and the elimination of electric power generation would have only slightly reduced the fixed charges and labor costs of the power plant.

As the power plant buildings are of sufficient size to house both steam and electric generating equipment for a demand of about 35,000 kw., the predicted load, it was found to be more economical to replace the existing boilers with the largest units that could be got into the available space and to replace the older types of turbine-alternators with larger, more efficient units, rather than to extend the buildings.

The history of the development of power facilities at the Hawthorne Works has closely paralleled the progress in the art of electric generation and distribution. The initial plant included: First, cross-compound condensing corliss engines with direct-connected 220-volt direct-current generators feeding a 220-volt distribution system; then 2,000-kw., 1,800-r.p.m., 460-volt, 60-cycle alternating-current steam turbine-generators with jet condensers, and later 3,600-r.p.m. machines feeding a 460-volt alternating-current distribution system; later newly developed mixed-pressure turbines to use the surplus exhaust steam from steam-driven auxiliaries and to furnish steam for heating; and, lastly, as provided in the recent alterations, 7,500-kw., 3,600-r.p.m., 12,000-volt turbine-generators with surface condensers feeding a 12,000-volt distribution system with substations centrally located transforming to 460 volts. The greater economies and better design of equipment readily were proved in the generation of current at 12,000 volts as compared with 460 volts.

The limiting factor in the selection of the turbine-generators was the over-all length of the machines, the space available between the generator and the switchboard for the withdrawal of rotors and shafts and the space required for condensing equipment in the basement. As a first step in the present expansion program, it was decided to replace the 460-volt stator on an existing 5,000-kw. turbine-generator with a 12,000-volt stator and to replace two old 2,500-kw. units with 7,500-kw., 12,000-volt turbine-generators with surface condensers.

Prior to 1928 electric power generation and distribution were at 460 volts, 3 phases, 60 cycles, using a four-wire grounded system. Three-conductor lead-covered,

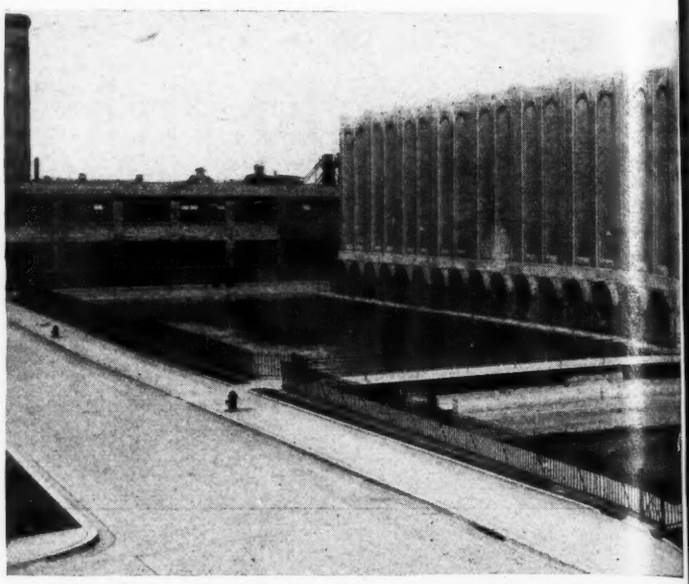
paper-insulated, 250,000-circ.mil cables, located on hangers in the same underground tunnels used for steam, water, gas and air services, were carried from the generating station to distribution panels located in the individual buildings. In all cases where the power loads were large enough to require it, several cables were run in parallel.

Greatly increased demand for electric power led to a comparative study of continuing with 460-volt generation and distribution as compared with higher voltage. Available space for installation of cables in the network of tunnels had about reached its limit, the cable system taking up room that could be occupied advantageously by other fast-growing services. The added economies involved in generating and distributing over a smaller amount of copper to centrally located substations and releasing much-needed space in the tunnels for other service distribution led to a 12,000-volt underground duct distributing system, transmitting to centrally located substations in each major group of buildings. Three-conductor lead-covered, paper-insulated, 400,000-circ.mil cables were decided upon for transmission at 12,000 volts.

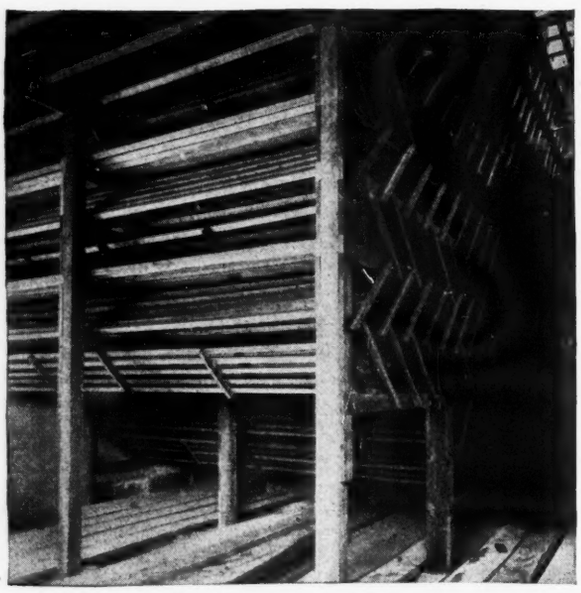
It is expected that the time involved in the complete replacement of the 460-volt generating and transmission systems with 12,000-volt systems will extend over a period of several years, during which time it will be necessary to generate and distribute both 460-volt and 12,000-volt power. It is therefore necessary to have busbar and transmission facilities for both voltages. The 460-volt and 12,000-volt systems are connected by two 3,000-kva., 3-phase, water-cooled, 12,000-460-volt tie-in transformers, equipped with induction voltage regulators which permit the passing of current from one system to the other as variations in the loads demand. This permits also of carrying only such stand-by generating capacity as would be normal for a generating system of only one voltage.

A one-story and basement extension was built on to the east end of the turbine room to house the 12,000-volt metal-clad oil circuit breakers controlling the generators and outgoing feeders. Each outgoing feeder is equipped with a combined disconnect and grounding switch of the remote manually operated type inclosed in a locked steel housing. In designing the high-voltage control switchboard it was considered that the existing 460-volt board eventually would be supplanted. For the best ultimate arrangement, the replacement of the old panels was commenced near the center of the board.

Five transformer substations have been built and put into service, and the sixth is in process of construction. These range in capacity from 1,000 to 9,000 kva. In general, each substation has at least two feeders from the power station, one regular and one emergency. The incoming end of each feeder is equipped with a combined disconnect and grounding switch similar to those in the power station. The oil circuit breakers in the substations are of the metal-clad type and are of a low interrupting capacity.



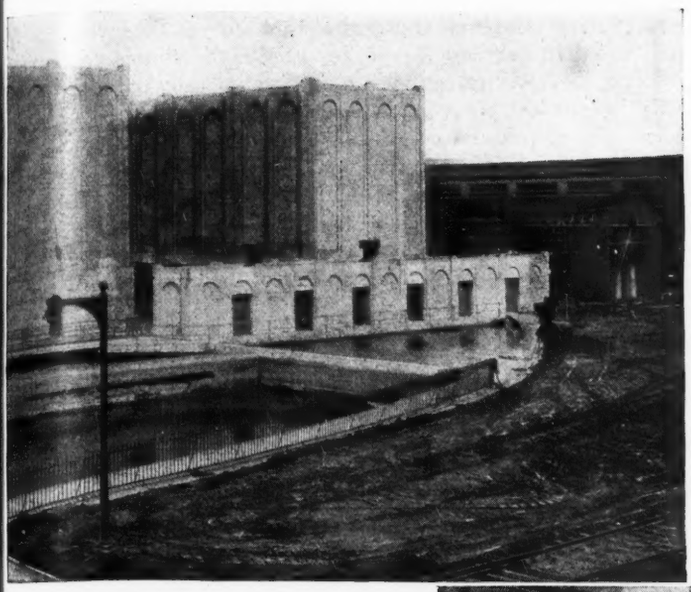
For the most part the substations are built on the roofs of the groups of buildings served. The transformers and high-voltage switching equipment are in one room and the low-voltage distribution switchboard and control panels are in an adjoining room separated by a fire wall. The substation supplying power to the cooling towers and pump house is of the outdoor type.



Interior of cooling tower cell, showing cypress baffling

Originally prime movers at the Hawthorne works were corliss engines exhausting into surface condensers. Much of the make-up water for the house supply and condensing water system was deep-well water heavily charged with incrusting solids, which resulted in fouling of condenser tubes. Jet condensers were selected when the engine-driven electric generating equipment was replaced by turbine-generators. During the last several years many manufacturing processes have been adopted which use Lake Michigan water for cooling. The increased supply of Lake Michigan water from these operations, combined with the decrease in the output from the deepwells, made available a supply of condenser cooling water free from incrusting solids; therefore in the last reconstruction program surface condensers were again adopted.

As the Hawthorne works is several miles from an ample source of natural water suitable for condensing purposes, the engineers who laid out the initial plant, in 1904, provided a four-million gallon water storage reservoir with a spray system for cooling condenser water and furnishing an ample water supply for fire protection.



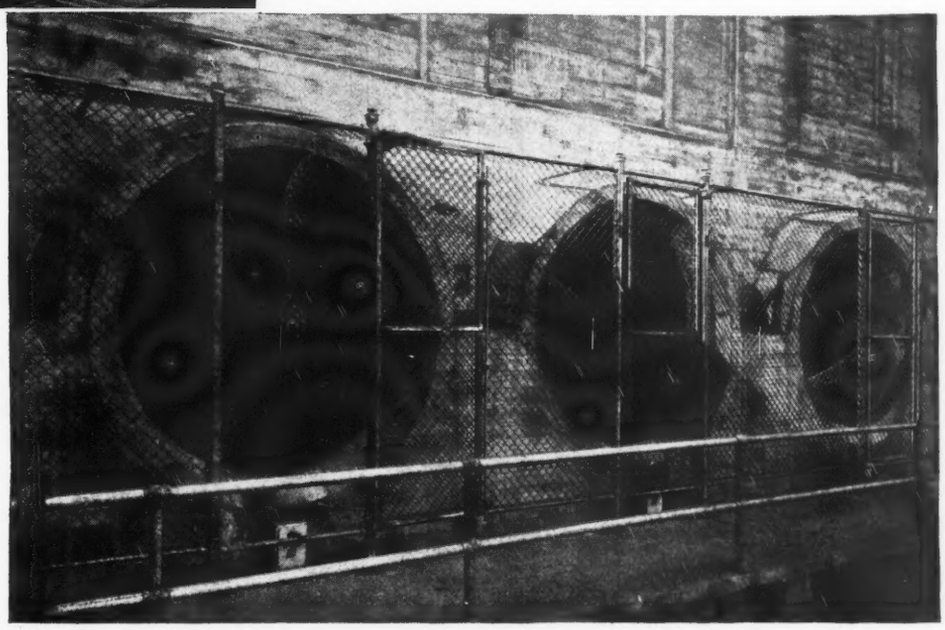
water from the warm water compartment of the reservoir, discharging it to a distributing system of troughs near the tops of the cooling towers, and from thence the water is sprayed down through a network of slats to the cold-water compartments of the reservoir under the towers. Air is blown upward through the network of slats and the falling water by airplane propeller fans.

A partitioned-off section of the reservoir is used to accumulate the return cooling water from the various manufacturing processes. The house pumps take the water from this section of the reservoir and distribute to the general house water system of the plant. Thus the water for process cooling is repeatedly used as such and ultimately used also for house water. Make-up for the house water may be supplied from a deepwell, from the city water supply, or from the condenser water cooling system.

Development of the boiler room also presented opportunities for substantial improvement wherever changes

THE LARGEST COOLING TOWER IN AMERICA

is a feature of Western Electric's new Hawthorne plant, an exterior view of which is shown above. The close-up view at the right shows the airplane propeller fans, which force air upward through the falling water.



The capacity of the spray system for condenser water had become inadequate, so in the recent power plant reconstruction it was replaced by a modern forced-draft cooling tower installation which is said to be the largest of its kind.

There are two towers, each 180 ft. long, 38 ft. wide and 50 ft. high. Each tower is divided into eight independent compartments, or cells, of 2,000 kw. capacity, served by four airplane fans, two on each side of the compartment, or a total of 64 for the two towers. Individual capacity of each cell for a 17-deg. drop is 3,800 gal. per minute. Total capacity of the two towers is 60,800 gal. per minute, which means 3,648,000 gal. per hour, or more than 87,000,000 gal. in the course of a 24-hour day.

To increase the capacity of the condensing water system, the single lines of existing 42-in. supply and return mains were continued through the end of the power house and connected to the cooling pond, thus forming a water return and supply through either one or both legs of the loop. The pump house is located over a triangular-shaped portion of the reservoir, to which the warm water from the condensers is delivered. The pumps draw the

or additions were required. The initial boiler house layout included low-setting horizontal water-tube boilers, which later were equipped with superheaters when turbines were installed for electric generation, and with natural-draft chain-grate stokers adapted to burning low-grade Illinois coals. Cast-iron tube economizers for 150-lb. pressure were provided on four-boiler groups, and later external individual economizers were installed on some units.

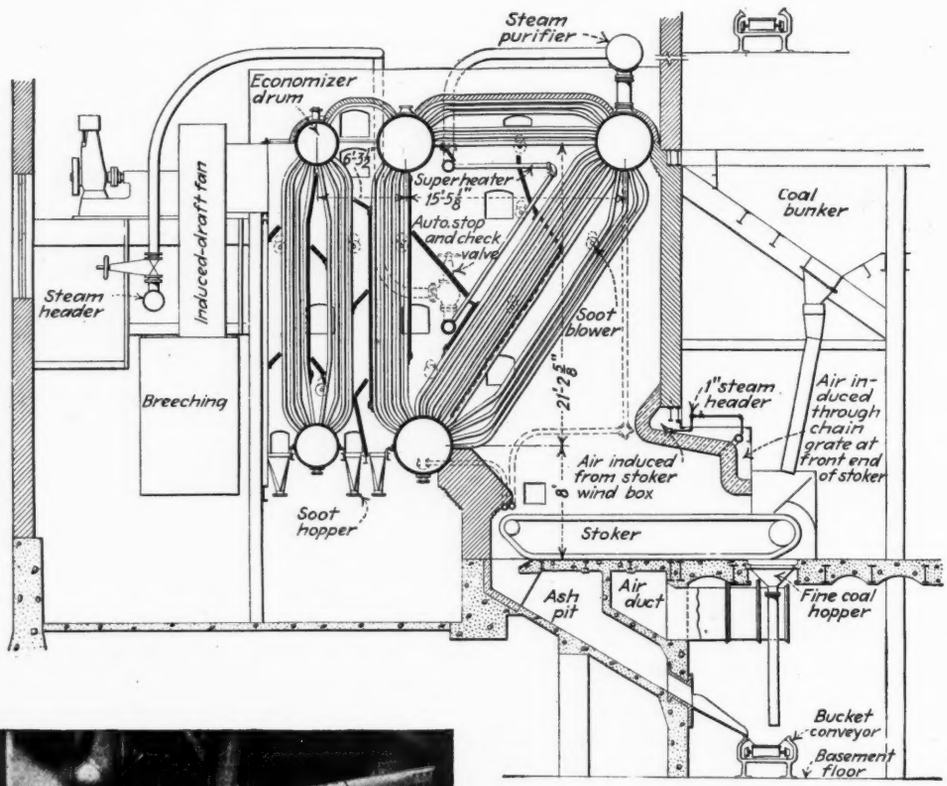
In the recent reconstruction, the boiler units were replaced by inclined water-tube boilers with vertical integral economizers, forced- and induced-draft fan systems, and forced-draft chain-grate stokers. The first reciprocating power feed pumps were replaced by centrifugal pumps, and the cast-iron feed-water heater by a modern deaërating heater.

Owing to the better economies to be had with high steam pressures, provision was made in the steam-generating and steam-using equipment for the use of 250- instead of 150-lb. steam when it seems advisable. The boiler plant is called upon to meet substantial demands for process steam. The combination of demands for process steam, electric power and light generation, gen-

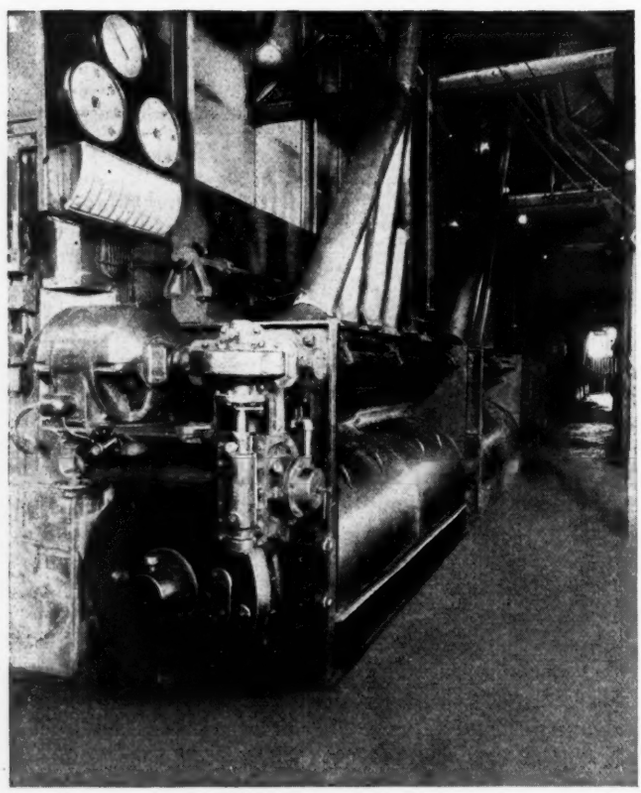
eral heating, compressed air in three pressures, and drinking water supply, all on one power plant presented an opportunity for providing these services economically.

As stated before, the height of the existing boiler house and the spacing of building columns materially affected the selection and arrangement of equipment. To obtain the greatest boiler capacity for the space available inclined water-tube boilers with vertical integral economizers were installed. The latest furnaces have water-cooled walls, front walls, and arches, forced- and induced-draft systems, and chain-grate stokers—a layout well suited to burning the poorer grades of Illinois coal and one that has proved its ability to operate economically up to 300 per cent of the nominal rating of the boiler. If required to meet an emergency or extreme demands, operation up to 350 per cent rating is possible.

The first four boiler units were provided with radial-type blowers for forced draft. Satisfactory operation, however, of airplane-type propellers for movement of air in the new cooling towers led to the adoption of airplane propeller blowers for the later boiler units. The compact arrangement of the propeller units in the space available was one of the determining factors leading to their selection, but not until an experimental installation had proved the adaptability of this type of equipment, as well as revealing a slight increase in efficiency.



Sectional elevation through boiler unit



The boilers are equipped with forced-draft chain-grate stokers

Steel casings were adapted for the boiler settings to reduce infiltration of air. Savings from operation at a higher CO_2 content have been sufficient to warrant the cost of this airtight form of setting. With steel casings the use of a greater thickness of heat-insulating materials in the side walls was permitted, resulting in a reduction in the loss of heat through the walls.

The original method of delivering coal to the storage bunkers in front of the boilers consisted of manually unloading the coal from the railroad cars from a track directly over the storage bunkers. The ashes were manually loaded into railroad cars on tracks leading to and from the basement of the boiler room. A combination system of pivoted bucket conveyors for handling the coal and ashes between the boiler plant and a separate coal- and ash-handling building replaced the original method. The coal is delivered to the bunkers in front of the boilers from the upper runs of the conveyor system and

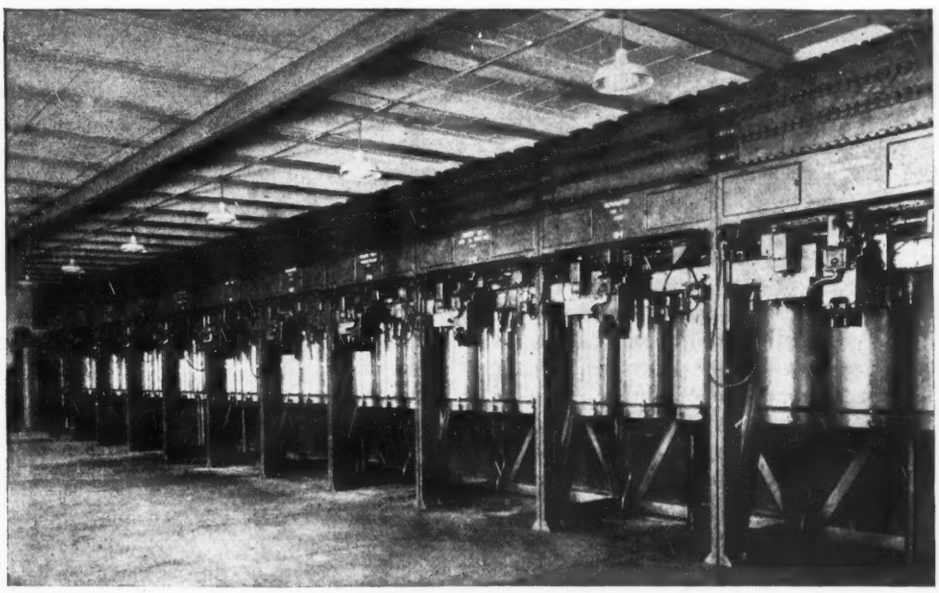
New Mechanical Equipment in Hawthorne Plant of Western Electric Company

Boilers, 12, 3-drum inclined, 7,213 sq.ft. each; 3¼-in. tubes; 48-in. drums; max. wk. press. 275 lb.; operation to 350 per cent rating ..... Erie City Iron Works
Economizers, 12, integral, 2,740 sq.ft. each; 3¼-in. tubes; 36-in. drums ..... Erie City Iron Works
Superheaters, 12, convection; four welded-steel type, 100 deg. F. ..... Superheater Co.
Eight with c.i. rings and steel core, 105 deg. F. ..... Foster-Wheeler Corp.
Stokers, 12, forced-draft, chain-grate; each 10 ft. 6 in. wide, 17 ft. long, 178.5 sq.ft.; drive, var.-sp.d.-c. motor, 5 to 20 hp., 900-450 r.p.m.; manually operated speed control.... Illinois Stoker Co.
Steam purifiers, 12 ..... Centrifix Corp.
Feed-water regulators, S-C ..... Swartwout Company
Soot blowers, 6 units per boiler, 3 units per economizer, Diamond Power Spec. Corp.
Compound feeders, Economy chemical pressure feeders, F. X. Farrel Co.
Water columns ..... Reliance Gauge Column Co.
Valves:
Blowoff ..... Everlasting Valve Co.
Non-return ..... Schutte & Koerting Co.
Safety valves ..... Consolidated Ashcroft Hancock Co.
Gate and globe ..... Crane Co.
Angle ..... Crosby Steam Gage & Valve Co.
Pipe and fittings for 300 lb. pressure ..... Crane Co.
Pipe covering, rock wool ..... Johns-Manville Corp.
Insulation on boilers and breeching, rock woll, Johns-Manville Corp.
Steel boiler casing, breeching and fan connections, Hamler Boiler & Tank Co.
Instruments:
Steam flow meters, ind., rec. and int... Republic Flow Meters Co.
CO_2 recorders ..... Republic Flow Meters Co.
Draft gages ..... Hays Corporation
Temperature recorders ..... Foxboro Co.
Pressure gages ..... Crosby Steam Gage & Valve Co.
Feed-Water meter; ind., rec. and int., 900,000 lb. per hr., Republic Flow Meters Co.
Coal scale, testing ..... Richardson Scale Co.
Fans, induced draft, 12, 48,000 c.f.m. each, 3½ in. stat. press. 450 deg. F., 430 r.p.m.; drive, 38-hp. Engberg 7x7-in. slide-valve engine; control, aut. by st. press..... New York Blower Co.
Fans, forced-draft, 4, dbl. width cent., 42-in. rotor; 30,000 c.f.m. each 2½-in. st. press., 70 deg. F.; drive, 20-hp. ind. G. E. motor, 900 r.p.m. ..... New York Blower Co.
Fans, forced-draft, 8, airplane propeller barrel type, 42-in. diam.; 30,000 c.f.m. each, 2½-in. stat. press., 90 deg. F.; drive, 15-hp. ind. G.E. motor, 1,800 r.p.m..... Hartzell Propeller Fan Co.
Heater, feed-water, hor. deaërating with vent condenser; 750,000 lb. per hr. from 60 to 212.6 deg..... Elliott Co.
Pump, boiler feed, one 4-stage cent., 2,000 g.p.m., 530 or 770 ft. hd.; drive, Winton steam turbine, 1,530 or 1,850 r.p.m., 343 or 500 hp. ..... Manistee Iron Works Co.
Air compressor, one, recip. st. drive; 2-stage air, s.s. steam; 22x16 and 28x40-in.; 7,650 c.f.m. free air, 100 lb. g., 150 r.p.m.; intercooler, 900 sq.ft.; aftercooler, 825 sq.ft.... Nordberg Mfg. Co.
Turbine-generators, two, 7,500 kw. at 80 per cent p.f.; 150 or 250 lb., g., 100 deg. superheat, 3-in. abs.; 3,600 r.p.m.; 12,000-volt, 60-cycle, 3-phase, star-con. generators; economy on 150 lb. steam, 14.45 lb. per kw.-hr..... General Electric Co.
Condensers, two, surface, 2-pass hor., 11,000 sq.ft. each, ¾-in. x 18-ft. tubes; capacity, 108,585 lb. steam per hr., 90 deg. F. inlet water temp. ..... Allis-Chalmers Mfg. Co.
Circulating pumps, two, s.s., 20x20 in., 12,000 g.p.m. each, 20-ft. hd., 490 r.p.m.; drive, 100-hp. G.E. ind. motor, Allis-Chalmers Mfg. Co.
Condensate pumps, two, s.s., 6x3 in., 325 g.p.m., 110 ft. hd., 1,740 r.p.m.; drive, 15-hp. G.E. ind. motor... Allis-Chalmers Mfg. Co.
Air ejectors, two, Croll-Reynolds 4-noz. steam-jet, 2-stage with surface inter- and aftercooler ..... Allis-Chalmers Mfg. Co.
Cooling towers, two, forced-draft; eight 22x36x50-ft.-high cells per tower; shells, reinforced concrete; filling, self-supporting cypress; cap. per cell, 3,800 g.p.m.; temp. drop, 106.5 to 89.5 deg.; air temp., 80 deg. F.; rel. hum., 70 per cent; total cap. of towers, 60,800 g.p.m. or 32,000 kw..... Foster-Wheeler Corp.
Forced-draft fans for towers, 2-blade airplane propeller type, 96 in., 4 per cell; fan capacity, 65,000 c.f.m. each; drive 15-hp. inclosed ind. motor, 690 r.p.m..... Paragon Engineers, Inc.
Pumps for cooling towers:
Two s.s. 20-in., 14,000 g.p.m., 41-ft. hd., 700 r.p.m.; drive, 200-hp. G.E. ind. motor..... Foster-Wheeler Corp.
Two s.s. 24-in. 20,000 g.p.m., 38-ft. hd, 490 r.p.m.; drive, 250-hp. G.E. ind. motor..... Worthington Pump & Mach. Corp.

the ashes are discharged direct from the ashpits under the boilers into the lower runs of the conveyor system. In the coal- and ash-handling building, provision is made for unloading the coal either from drop-bottom cars or by clamshell bucket, and storing the ashes in the upper part of the building and delivering by gravity directly into the railroad cars.

The original design of the power plant provided for a vacuum heating system taking low-pressure exhaust steam from various auxiliary equipment for heating the manufacturing buildings, and all steam-driven equipment in the power house other than the turbines driving electric generators was installed non-condensing. The success of the vacuum system varied with the distance of a building from the power plant, the ones farthest from the power plant obtaining rather unsatisfactory results. An extensive study resulted in changing to a forced-circulation hot-water heating system, the water being heated in four closed heaters taking exhaust steam at between 1 and 2 lb. pressure from the auxiliaries and bleeder turbines.

To insure a continuous supply of best-grade lubricating oil for the high-speed turbine-generators, a continuous oil filter has been installed. Portions of the oil from the storage chambers under the turbines are continually being passed through this filter, which removes the sedimentation and any possible moisture that may be contained in the oil.



▼ **The 12,000-volt, metal-clad oil circuit breakers are housed in an extension built on the east end of the turbine room**

PULVERIZING QUALITY and FUEL VALUE . . .

Factors in Coal Selection

By G. B. GOULD
President
Fuel Engineering Company of New York

The author presents a standard "index" of pulverizing quality and shows how coals are grouped in terms of this index. He gives practical hints on selecting coals of lowest heat cost without sacrificing capacity or furnace efficiency or incurring excessive cost of pulverization

THE DEVELOPMENT of burning coal in pulverized form changed the meaning that had customarily been attached to a number of well-known and frequently measured coal characteristics. For example, the percentage of volatile matter and the fusing point of the ash have a bearing on coal selection for pulverizer use, but in quite a different way from their relation to the selection of coal for use on a solid fuel bed.

These characteristics, as well as a number of others, had been measured for years; but pulverized coal burning brought to the fore still another characteristic in respect to which coals from different mines vary from one another, a characteristic of no importance to any other method of coal burning and consequently one about which almost nothing was known. It was early discovered from practical trials that the capacity of a pulverizer to deliver a product of the desired degree of fineness varied considerably with different coals. And, of course, the successful operation of a pulverized-coal unit requires the coal to be reduced as nearly as possible to a point where at least 70 per cent of it will pass a 200-mesh screen. Previous experience in crushing coal to the usual commercial sizes was useless, because it is such a crude process by comparison with reduction of coal to a size which will permit it to pass through a screen having about 40,000 openings per square inch.

While only a small proportion of our coal is burned in pulverized form, the relative grindability of different coals is a matter of real importance to those plants which do burn coal in this way and to those who may contemplate the adoption of this method of burning. As an indication of how new the whole subject is, there is no established method of testing coal for its hardness, nor any recognized standards.

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In our own work of coal selection, it became necessary, however, to discriminate among coals as to their relative suitability for pulverizer use. To rely on practical plant trials is too slow and clumsy a method. And in addition there is no standard for rating the capacity of pulverizers, so that the experience in one plant could not readily be transferred to another plant. In fact, a coal which is successfully used in one plant would reduce the capacity of another plant by a quarter or a third. Just as always has been the case with stoker-fired plants, each plant has its own individual requirements, which must be determined. But if coal characteristics can also be separately measured, and the two related, coal selection can be conducted with greater accuracy, speed and economy.

In order to discriminate among coals according to their grindability, we provided equipment in which coal samples can be subjected to a uniform grinding effect for a definite length of time. By mechanical screening equipment, the resulting sizes are separated from one another, and weighed, so that each coal can be given a rank. By experiment, the various factors were adjusted so that between 80 and 90 per cent of the softest coals would pass through a 200-mesh screen at the end of the test, while only a small percentage of anthracite would do so.

These experiments also led to the conclusion that all coals do not respond alike to variations in mill loading. As a mill becomes overloaded, the proportion of the coal which is reduced to 200-mesh tends to decrease, but this tendency is much more marked with some coals than with others. The result is that several coals which have the same grinding index at one mill load may be quite widely separated if the mill is more heavily loaded. For this reason it became necessary to subject each coal to two different grinding tests, one representing a heavier load than the other, the two conditions representing, roughly, the range of practical experience in pulverizer plants as we find them today. For convenience, the two resulting scales are designated as the "overload" and "underload" scales.

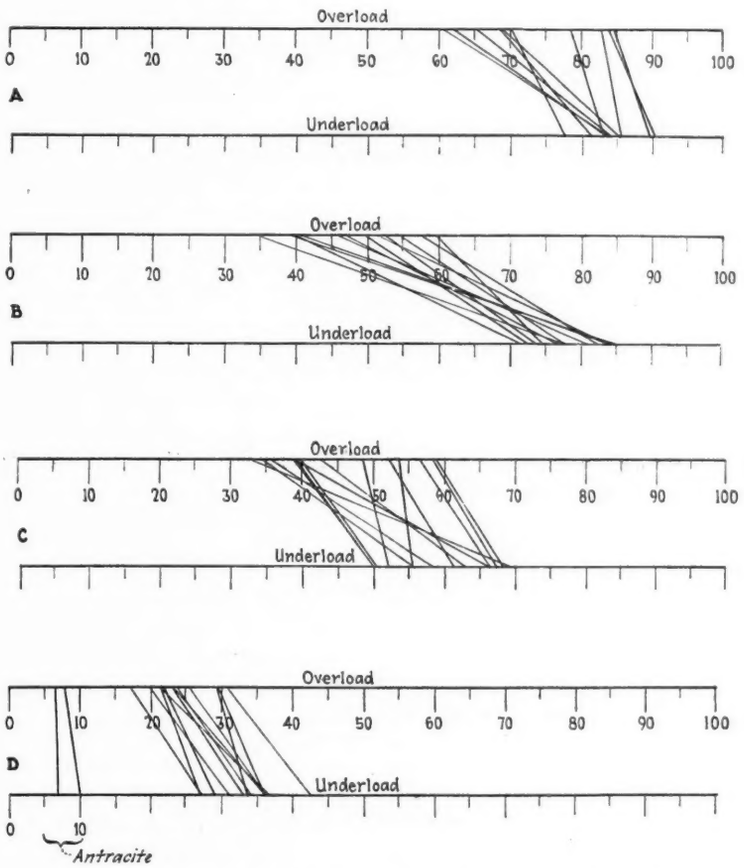
The accumulated data discloses some interesting facts about American bituminous coals with respect to their suitability for pulverizer service. The coals naturally

fall into four rather distinct groups, according to their grinding characteristics, and, as usual with coal characteristics, this one seems to have very little relation to any other coal quality. The four groups, designated as A, B, C and D are divided as follows:

TABLE I—GRINDING CHARACTERISTICS OF FOUR COALS

Group	Overload Index	Underload Index
A	Over 60	Over 70
B	30–60	Over 70
C	30–60	50–70
D	10–30	20–50

The relation of the several groups and the individual coals to each other can be seen by presenting the data graphically. For this purpose two parallel scales are used, and the two indices for each coal are connected by a line. Some fifty coals, representative of thirty districts in seven states (Pennsylvania, Maryland, West Virginia, Virginia, Kentucky, Indiana and Illinois) and covering the whole scale of grindability, have been plotted, and are reproduced on this page.



Range of pulverizing index of typical coals in Groups A, B, C and D

It will be seen at once that three of these groups, A, C and D, are definitely distinguished from each other on both scales, although the individual coals within each group show considerable variation, as disclosed by the slope of their rating lines. Group B, however, contains coals which are comparable to those in Group A on the underload scale, but to the harder Group C on the overload scale.

Comparison of the three groups A, B and C reveals why plant tests, or a single scale of grindability, may be very deceptive. Coals properly ranking in Group B might be classed along with coals in Group A, if tried in a plant operating at a moderate mill rating, and yet yield quite different results in the same plant when carrying a heavier load. For example, one plant operating well within its mill capacity changed from a coal in Group A having an index 79-85, one of the softest coals in the group, to a coal in Group C, with an index of 40-50; the only result was a 20-per cent increase in the power consumed in grinding. Several other plants within our knowledge have tried the same thing and have suffered a serious impairment of plant capacity.

TABLE II—COMPARATIVE DATA OBTAINED FROM REPRESENTATIVE COAL SAMPLES

Group	Grinding Index—Overload	Grinding Index—Underload	B.t.u. Dry	Cost per Ton	Relative Value (B.t.u. Basis)
A	74	84	14,445	$4.44	Base
B	48	78	14,035	4.12	$4.31
C	45	60	13,750	4.06	4.21

Study of the grinding index for a large number of coals representing nearly every important seam and district reveals only a general relationship to geographical or geological classifications. So far, no coals have been found in the A, B or C groups that did not come from the Northern Appalachian field; that is, the coal fields of Pennsylvania, Maryland, Virginia and West Virginia. Some coals from these fields are also found in Group D. Also, none of the strictly high-volatile coals from the Pittsburgh, Connellsville and Fairmont districts has appeared in either Group A or B.

Some of the high-volatile coals (30-32 per cent) originating east of these districts are found in both of these groups, as well as in Group C. New River coals have appeared only in Groups A and B. While differing from one another but slightly on the underload scale, these usually show considerable variations on the overload rating, all the way from 35 to 69. Group D, in addition to some high-volatile coals from Pennsylvania and West Virginia, includes the Middle Western coals tested up to this time. The low-volatile coals from Clearfield, Cambria and Somerset counties in Pennsylvania are found over nearly the entire range of the three groups A, B and C. From the standpoint of seams, generalizations are even more difficult. In each of the first three groups at least five seams are represented. The Lower Freeport coals seem, in a very general way, to have the best record, although individual coals from several other seams have a higher grinding index than individual coals from the Lower Freeport. These coals appear in both A and B groups, but only in the upper register of the C group. Somewhat like the New River coals, they differ from one another much less on the underload scale than on the overload rating. The Pittsburgh and Sewickley seams do not appear at all in the A or B groups.

While generalizations about coal qualities are instructive and helpful as a background to the appraisal of the individual coals, they are dangerous if used as a substitute for actual measurements of the qualities of each coal. The fact that a large majority of the coals in Group A have less than 26 per cent volatile does not mean that all low-volatile coals are easy to pulverize, for

there are some coals under 26 per cent in volatile in both the B and C groups. Likewise, the fact that the coals easy to pulverize are generally more costly, as will be shown in another place, does not mean that all coals in Group A are less desirable economically than some coals with a lower grinding index. Nor does the fact that most of the Group A coals bring a higher price mean that they bring a premium in the market *because* they are easy to pulverize, for there are other factors which are more powerful in determining market values than the demand for coals having the highest grinding index.

There are some angles to this question of grindability which, with refinements of our knowledge, will be worth further investigation. There is the question of uniformity of grinding index for the product of a given mine. With a large mass of data study, it can be demonstrated that some mines produce a much more uniform product than other mines with respect to those qualities it has been customary to measure. Just what can be considered a normal variation in grinding index for a given mine, and how much mines may differ from each other in the uniformity of grinding index can only be determined from a large mass of organized data on the subject.

It has also been suggested that the separation of coal into sizes at the mine may automatically segregate portions of the coal which are harder or easier to pulverize, depending on the structure of the coal in the particular mine, and how the coal happens to break up. For example, in the case of coals which contain a large proportion of coal of a dense structure throughout the vein a separation into sizes would not be expected to cause any great difference in the grinding index.

On the other hand, in some districts the coal is often found in alternating layers, some of which are considerably less friable than the others: in such cases a separation of sizes might segregate that portion of the coal most easily pulverized. And at the other end of the scale, coals of a more uniform but friable nature, while probably easier to pulverize, would show little variation in grinding index as a result of sizing.

Coal is classified according to its structure into Vitrain, Clarain, Durain and Fusain, ranging in hardness in this order, and individual veins are composed of varying proportions of these different classes. It is possible that a combination of coal of dense and friable structure in differing proportions is responsible for the different ways in which individual coals respond to mill loading, as already mentioned and indicated by the differing slopes of the lines on the rating charts. While a relative rating of coals according to grindability is immediately important to the individual coal buyer, the answer to these other questions may ultimately affect him by influencing the development of coal preparation methods at the mines.

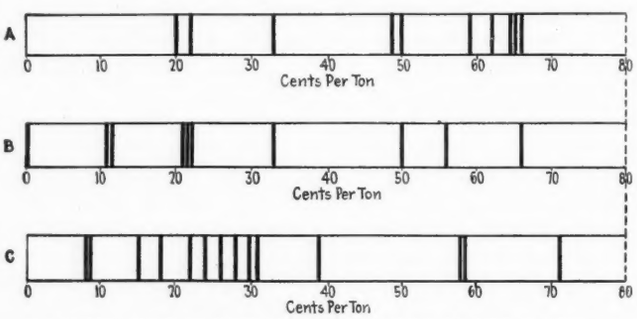
A classification of coals according to their grinding index, no matter how important it may be from a purely engineering standpoint, is of little economic significance unless it is related to actual market values. Choosing a coal that meets the engineering requirements of good operation is, after all, only an intermediate objective. Another intermediate objective is the choice of a coal that yields the most energy per dollar. And the final objective is the best combination of these two, to secure the lowest cost of steam.

For example, if one's plant equipment and operating requirements are such that Group A coals are required, then the problem is to choose the best values, quality and price both considered, within that classification. If Group B or C coals can be included the field of choice will be correspondingly increased, and, as will be shown later, better values can be secured, at least under present market conditions.

This is more important in the East than in sections like Illinois, where the near-by coals vary over a much narrower range of grindability entirely within Group D. Among the coals from southern West Virginia there is less variation, on the whole, in heat value and price than in most other sections, but a considerable range in grindability, especially on the overload scale.

The coal consumer in the Middle Atlantic States and western New England may choose from coals with a greater variety of characteristics, a wider range of values and more different combinations of qualities than a coal consumer in any other important industrial section of the world. And now it appears that the coals available to this section, which come from Pennsylvania, Maryland and northern West Virginia, likewise offer the widest range of grindability. A survey of market values available in this district in relation to grinding rank reveals some interesting facts.

No one buys coal simply because it grinds easily—at least, not unless he has to. The grinding index of a coal is simply one consideration of varying degrees of importance, depending on the plant equipment and operating conditions. Coal is bought for the energy it contains, which is measured and expressed as British thermal units; and for any individual buyer its value depends upon how much of the energy can be recovered in his particularly plant. It is not possible here to differentiate among coals as to their energy value, except on the basis of the total energy they contain. Further refinement depends upon consideration of other coal characteristics as they relate to individual plants.



COMPARATIVE FUEL VALUES OF 34 COALS, BASED ON PRICE, FREIGHT AND HEAT VALUE

Each coal is represented by a vertical line at a point on the scale indicating the number of cents by which the price would have to be reduced to equal the best individual value.

For the sake of illustration, we have taken 34 coals, more or less at random, as a fair sample of existing market possibilities, and on which prices have been quoted to our clients during the month of September, 1930. Ten of these fall in Group A, 10 in Group B and 14 in Group C. For each coal the average quality available in our files, and established from a series of samples taken from 2,476 actual shipments, has been used as the basis for comparison. To put them all on a comparative basis, the delivered cost has been calculated by applying the freight rate to one selected destination. The average grinding index, B.t.u. dry, and the average delivered cost per net ton for all the coals in each group are shown in Table II, together with the relative value of Groups B and C, compared to Group A.

It is apparent at a glance that on the average the coals which are easier to pulverize are higher in heat value, and also higher in price. In the last column is given the relative value of Groups B and C, compared with Group A—that is, the average price at which these coals would yield the same amount of heat for each dollar. From this it can be seen that the coals in Group B are, on the average, 19c. a ton cheaper than Group A coals, after allowing for differences in quality, freight rates and price. Group C coals, on the average, are 15c. ahead of Group A, but not quite as good as Group B.

But averages are apt to be deceptive, especially in the case of coal values, which vary so much. For example, if two coals are eliminated from Group A average, Group B coals have an average value 26c. a ton above the remaining eight coals in Group A. One of the two coals thus eliminated from Group A is a resultant coal from the low-volatile fields, of which there are at the present time very few, and the other is an exceptionally soft high-volatile coal, obtainable in a slack size. This difference of 26 cents in average value between the two groups, A and B, arrived at by removing the two exceptional coals from the A group, more nearly represents the typical difference between the two groups in this respect.

Averages are, however, only a convenient mathematical method of stating very general facts. The individual coal consumer does not actually buy a coal of average quality at an average price. He buys one or two individual coals to suit his particular purposes, and, of course, if they can be found, the one or two which offer the best value within his own particular limitations in coal selection. It is interesting, therefore, to examine briefly the individual coals comprising these three groups.

It is then found that entirely within the A group there is a range of values which, after allowing for differences in heat value, freight and price, is equivalent to 46c. a ton. And in each of the other two groups there is a range of value equivalent to over 60c. a ton.

It should be remembered that these differences are in value; not just differences in price; although price is, of course, one factor. And the particular values under consideration here do not include extremes of price at either end of the scale at which coals of comparable quality are being bought. Coals of no better quality than the highest-priced coals included in this survey are being sold at prices 30c. to 35c. higher; and in the lower price range coals are being offered at prices as much as 25c. below the lowest price which has been used here.

The relation of these 34 typical coals to each other in point of value, and according to their grinding index by groups, is best seen from the graphical summary on page 888. The individual coal which yields the highest energy value per dollar, based on its price, freight rate and average quality, happens to be in Group B, and is indicated by the vertical line at zero at the left of the horizontal bar representing the values in this group. Each of the other 33 coals is represented by a vertical line placed at the point indicating the number of cents per ton by which the price of each one would have to be reduced to bring it on a par with the best individual value.

It will be seen that no coals in Group A come within 20c. of the best attainable value. If these 34 coals were under consideration for use in a plant which required a coal having a grinding index in Group A, the best choice would be 20c. short of the best value. Of equal importance to the range in values is the distribution of values in the scale, for it will be noticed that most of the Group A coals are found near the low-value end of the scale, while the better values become more numerous, proportionately, in Group B, and still more numerous in Group C. In fact, the two best values in Group A are furnished by the two coals which have already been mentioned as exceptional for the group.

Incidentally, and as is usually the case in the coal market, neither the coal of highest quality nor the one offered at the lowest price represents the best value. It is the best combination of price and quality that counts, and in any group of coal offers this is usually found somewhere below the best quality and somewhere above the lowest price.

The distribution of these coals over the range of values illustrates another characteristic of the coal market that has an important bearing on steam generation in a number of different ways. As the engineering requirements of a plant increase the limitations placed on coal selection the number of suitable coals diminishes rapidly. Grindability represents an additional factor limiting the choice of coal.

In this case, if we should allow a liberal tolerance of 22c. variation from the best value obtainable, and if the plant limits the choice to Group A coals, it is necessary to find, identify, and accurately appraise in relation to the others just two coals out of 34. If Group B coals can be included, there are 8 coals, and if Group C can be added, any one of 13 out of the 34 coals will be within at least 22c. of the best value. Five coals will be within 11c. of the best value.

Such wide differences in value may seem startling, but they are actually typical of the coal market, and they have existed for many years. This is found to be true whether the coals are arranged according to their grinding index, or according to any one or more of their other physical qualities, when prices are properly related to an accurate measure of the average energy value of each coal. In this particular discussion, however, the coals are grouped according to their desirability from the standpoint of pulverization only.

If other limitations, such as a definite range of volatile, or fusing point, are added, the field of choice becomes still narrower. Under these circumstances, it can be readily seen that coal selection plays a part in steam generating economy equal in importance, measured by financial consequences, to the matter of boiler room efficiency. And so wide and so numerous are the variations in coal values at any time, and so unstable are these values, shifting as they often do from week to week, that a really discriminating coal buyer needs a considerable amount of accurate data merely to enable him to determine where a particular coal offer stands in the scale of attainable values at any given time.

✦

IN THE OCTOBER ISSUE of the *Proceedings* of the American Society of Civil Engineers, there appears an interesting and valuable paper on "Theory of Similarity and Models," by Benjamin F. Groat, consulting engineer, of Brookline, Mass. Basing his conclusions on data already collected, Mr. Groat presents a concise treatise on the theory of similarity and models. Newton's theorem, he shows, covers every possible type of dynamic model. Mr. Groat demonstrates that models can be built to specification, as to materials and their properties, so as to perform with theoretical exactness, and he suggests that materials, including fluids, should be sought, made or arranged so as to adapt them especially for service in models.

Refrigeration Speeds Production

at Seamless Rubber Co.

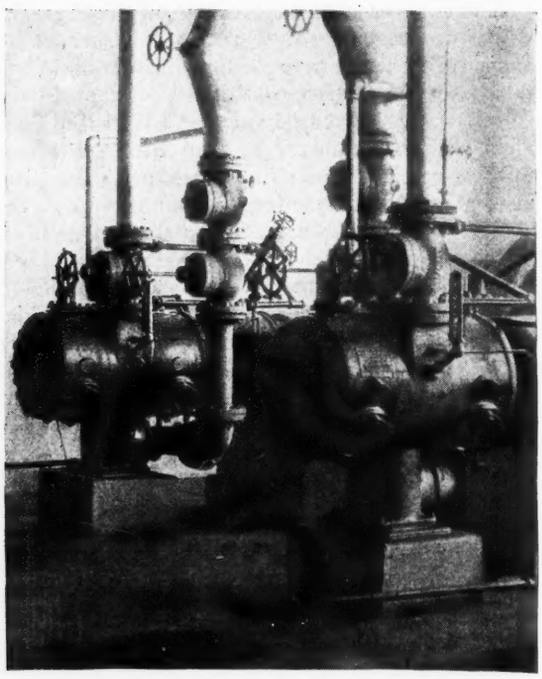


Fig. 1—The clearance pocket cylinders of one compressor

By WARREN P. SMITH

IN SPITE of the fact that cold temperature slows up activity, and in the case of some animals even causes bodily activity to entirely cease, refrigeration has been seized upon by industry as a means of speeding up production.

For example, in the manufacture of rubber goods some inquisitive engineer discovered that cold water would improve the quality of the goods and increase the output of a machine. So cold water is now used to "take the fire out of the stock" or check the curing during the operation of mixing and calendering, so that the stock may the better be handled during the later process of working the rubber into the finished product. In fact the modern method of adding accelerators to speed the processing makes a low temperature all the more necessary.

As natural water is seldom cold enough, artificial cooling means must be adopted in most plants, so the Seamless Rubber Company of New Haven, Conn., installed a 391-ton compression refrigerating plant to cool the water needed in rubber processing. In this plant the cold water is pumped through shell-and-tube coolers, such as generally used to cool brine, where it is reduced to its original temperature by ammonia. Due to the fact that in winter city water is cold enough, the refrigerating plant is operated only during the warm months.

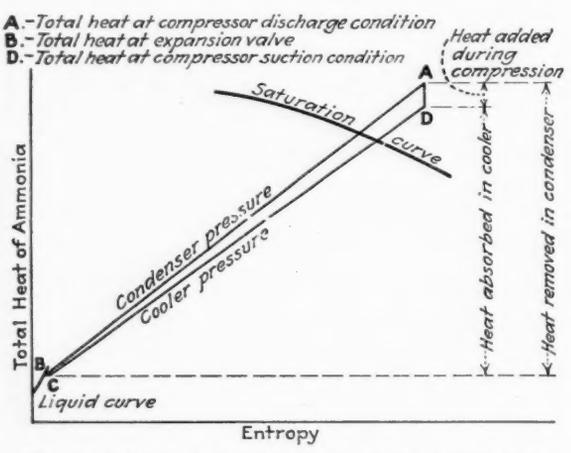


Fig. 2—Total heat diagram gives the theoretical work

The machinery installed in connection with the refrigeration system consists of a 9x9x14-in. duplex horizontal double-acting compressor driven by a 225-hp. synchronous motor, and a 9x14-in. single cylinder horizontal double-acting compressor driven by a 125-hp. synchronous motor. The foundation of the simplex machine was made large enough for a duplex compressor, so that a larger motor and another cylinder can be added when future increases in load demand it.

Each motor has a push-button starting panel, and there are two 9-kw. motor-generator sets for excitation, each large enough to excite both synchronous motors.

The condensers, which are in a room adjacent to the compressor room, consist of 42 multi-tube seven-pass sections arranged in six stands, seven sections high and provided with valves so that the ammonia may be shut off from any stand. A valve at each end of each section permits the water to be shut off while the tubes are being cleaned. There are two liquid receivers below the condensers, close to the floor, and the liquid lines pass under the coolers to the expansion valves, on the accessible side of the water coolers.

Two coolers, mounted on a structural steel frame, one above the other, are each covered with 4 in. of cork insulation. Cooler shells are 52 in. diameter and 20 ft. long and contain 268 2-in. 12-gage steel tubes, making the heat transfer surface 2,806 sq.ft. The water con-

nections on the ends of the coolers are arranged so that either cooler may be shut down for cleaning or repairs independently of the other, and also so that they may be operated either in series or in parallel.

Condensing water is pumped through the condensers and passes through a 12-in. line, across the roof of the power house addition and up to the roof of a five-story adjoining building, where it goes through spirodome spray nozzles and falls to the roof.

This spray pond is designed to cool 2,400 gal. of water per minute from 76 deg. to 71 deg. F. The nozzles are arranged in sixteen groups of six $1\frac{1}{2}$-in. nozzles per

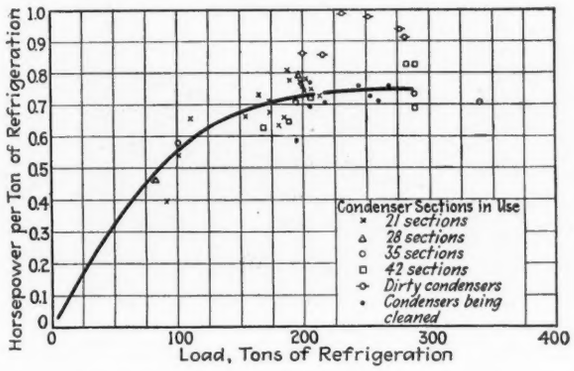


Fig. 3—Horsepower required per ton output

group, placed about 4 ft. from the roof. At the present time there are only 60 nozzles in operation, the others being shut off because of the lower capacity possible with the three compressor cylinders. An 8-ft. spray fence built along both sides of the spray pond prevents the spray from spreading over the neighborhood, which is essentially residential.

Cooled water leaving the roof passes down four drains into two pipe lines under the roof. These are connected to a tank on the fifth floor, at which point there is a float valve for make-up water. A vent pipe from this tank rises through the roof to a point near the level of the spray nozzles. There is another 12-in. pipe line passing down the side of the building and across the power house roof, parallel to the riser, which carries the water from the tank to the pump in the refrigeration room.

An 8-in., single-stage double-suction centrifugal pump circulates the water through the condensers and spray nozzles. At the present time this pump has an impeller designed for a capacity of 1,600 gal. per minute and is driven by a 30-hp. motor, but the casing is designed to accommodate an impeller capable of handling 2,500 gal. per minute when it becomes necessary to enlarge to the ultimate capacity, and the base plate is large enough for the larger motor.

All equipment handling ammonia is installed in the refrigeration room, and the pipe lines, valves and mixing chamber required by the new city ordinance for drawing off the ammonia in case of fire are outside the building.

A reservoir from which a 5-in. single-stage, double-suction, centrifugal circulating pump takes its suction collects the return refrigerating water from the mills and air conditioners. This reservoir is a steel tank insulated with cork and provided with a float valve for make-up water and a gage glass to show the water level. The water is pumped through the coolers and then divides between the mills and air conditioners. To prevent the control valves at the conditioners from pounding, a reducing valve was installed that maintains a pressure of about 25 lb. per square inch on this branch. All pipe lines carrying refrigerated water are covered with two layers of anti-sweat covering to eliminate objectionable drippings in the building.

The system is large enough to cool 1,000 gal. of water per minute from 54 deg. F. to 45 deg. F. Since the machine was installed the temperature requirement has been reduced to 39 deg. F. to prevent sweating of the equipment in the dipping department. Return water is usually about 52 deg. F.

As no means was provided for the measurement of water flow in either the cold water system or the condensing water system, the figures on the operation of the plant are only approximate, because they were found by a somewhat indirect method; but they give a comparison between different operating conditions. By the use of the input power to the motors, the pressures and temperatures at the compressors and the diagram shown in Fig. 2 the amount of ammonia circulated was calculated; then the heat removed from the water in the coolers and the heat removed from the ammonia in the condensers was found. Fig. 2 is based on Goodenough's total heat chart. Fig. 3 shows the horsepower per ton of refrigeration at

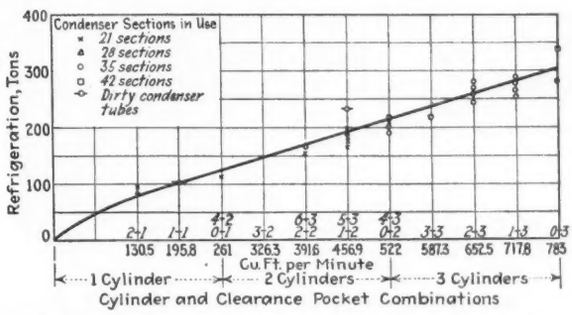

Refrigeration, Tons
Condenser Sections in Use
21 sections
28 sections
35 sections
42 sections
Dirty condenser tubes
2-1 1-1 4-2 3-2 6-3 5-3 4-3 3-3 2-3 1-3 0-3
0-1 0-1 0-1 1-2 2-2 1-2 0-2
1305 1958 261 3263 3916 4569 522 5873 6525 7178 783
Cu. Ft. per Minute
1 Cylinder
2 Cylinders
3 Cylinders
Cylinder and Clearance Pocket Combinations

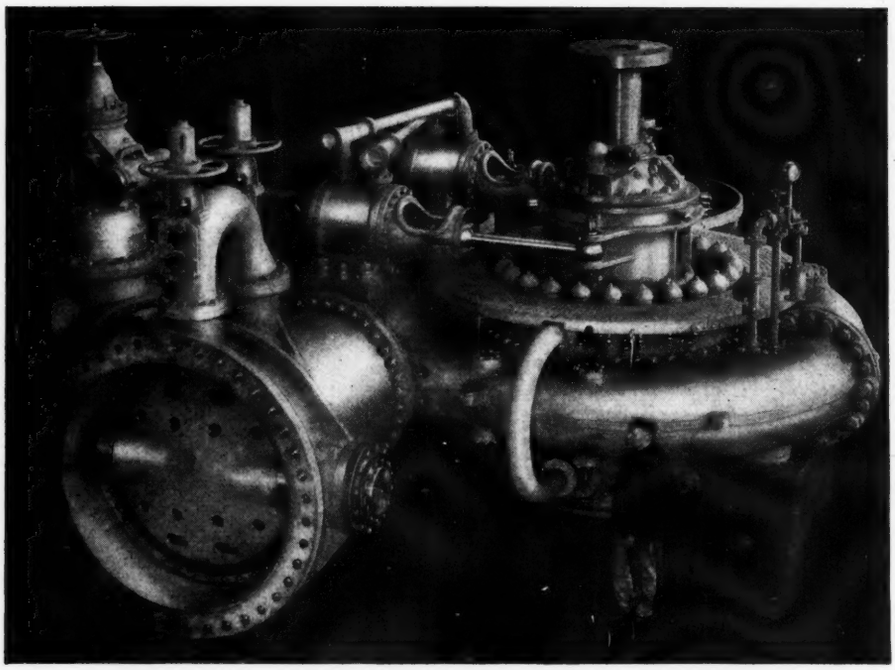
Fig. 4—Tonnage with various compressor clearances

different loads. It is interesting to note that the points are considerably above the curve for the tests made before the condenser tubes were cleaned. Excessive head pressures were carried during some of the hottest days last summer before the condensers were cleaned, going as high as 270 lb. per square inch on one occasion. But since they have been cleaned the head pressure has never been as high as 200 lb. per square inch. Since the tubes have been cleaned the machine has been operated with only a part of the condenser sections in use.

The curve in Fig. 4 shows the capacity at different combinations of cylinders and pocket valves. The clearance pocket combination gives a very flexible arrangement for efficiently handling the variations in load which are continually occurring, and is essential with constant-speed drives.

Principal Refrigerating Equipment Installed at Seamless Rubber Co.

Compressors, one 9x14 duplex and one 9x14 simple Ingersoll-Rand
Henry Vogt Machine Co.
Motors, one 225 hp. and one 125-hp. 237 r.p.m. 440-volt synchronous ..... General Electric Co.
Exciters, two, 9-kw. motor-generator sets.... General Electric Co.
Water coolers, two, 2,806-sq.ft., horizontal, 10-pass shell-and-tube
Henry Vogt Machine Co.
Ammonia condensers, six-stand, seven-pass, multi-tube
Henry Vogt Machine Co.
Liquid receivers ..... Henry Vogt Machine Co.
Ammonia accumulator ..... Henry Vogt Machine Co.
Cold-water piping, one 5-in. Cameron, 1,000 g.p.m. d.c. to 40-hp. G.E. motor ..... Ingersoll-Rand Co.
Condenser water pump, one 8-in., 1,600-r.p.m. centrifugal d.c. to 30-hp. G.E. motor ..... Ingersoll-Rand Co.
Spray nozzles, 96..... Cooling Tower Co.



Assembly of turbine, looking from penstock side

Service Record of Highest-Head Reaction Wheel

Five years' service and maintenance experience for a 35,000-hp. Francis-type turbine, operating under a head that varies from 860 to 930 ft., in the Oak Grove plant of the Pacific Northwest Public Service Company in Oregon

By E. D. SEARING
Advisory Engineer
Pacific Northwest Public Service Co.

AT THE Oak Grove hydro-electric plant of the Pacific Northwest Public Service Company the turbine enjoys the distinction of operating under the highest head of any Francis-type reaction unit. About three years prior to its installation, two turbines of similar construction, but of smaller size and slightly lower head, were installed in southern California, and there has recently been installed in the Southeast a turbine of approximately the same capacity and for slightly lower head. The Oak Grove turbine has retained its lead in size and operating pressure, and has been in regular commercial service for over five years. For this reason its operation over that period, and the amount and character of maintenance work, as well as the condition of the working parts at the present time, are of interest.

When the type of wheel for Oak Grove plant was being considered a combination of several favorable factors pointed to a Francis unit. As previously mentioned, reaction wheels for heads approaching that for which Oak Grove was being designed were in successful operation. The water for the proposed plant was fairly clean, with practically no mineral sediment, giving assurance of freedom from abrasion by the high-velocity water on the wetted surfaces of the turbine. The plant was to operate at a high load factor, therefore the difficulties frequently experienced from cavitation and pitting at part-gate operation would be eliminated. A Francis wheel of the low specific speed required would have a better efficiency over its normal working range than an impulse wheel of equal capacity and for the same conditions. The high-load factor at which the plant was to operate made the higher-efficiency unit preferable. The type of wheel selected has proved so successful that a second of practically the same design is now being installed.

The Oak Grove turbine is a vertical reaction unit rated at 35,000 hp., 849 ft. head, at 514 r.p.m., the actual operating head varying from 860 to 930 ft. It was built on the Pacific Coast by the Pelton Water Wheel Company. A spiral cast-steel casing is used and the guide vanes are also made of cast steel, while the throat liner plates

chamber liners and the runner are of bronze. A governor-operated, slow-closing relief valve that may also be used as a synchronous bypass is part of the control equipment. A 72-in. butterfly valve, operated either by an electric or a water motor, provides a shut-off at the casing inlet. The guide bearing is of the babbitt-lined oil-lubricated type, with suitable oil catchers and pans. An open space between the bottom of the bearing and the stuffing box prevents water from getting into the oil. This also allows for convenient repacking and inspection of the gland. The stuffing box is filled with a special semi-metallic graphite impregnated packing working in contact with a forged-steel sleeve shrunk on the shaft.

A 9-ft. diameter flow line 6.5 miles long terminates in a Johnson differential surge tank on the mountain above the plant. From there a 96-in., tapering to 72-in., pressure line extends 1,483 ft. to the turbine shut-off valve.

Because of the importance of the unit on the company's power system, care has been taken through regular inspections to assure its continued and uninterrupted operation. The turbine is inspected at regular intervals,

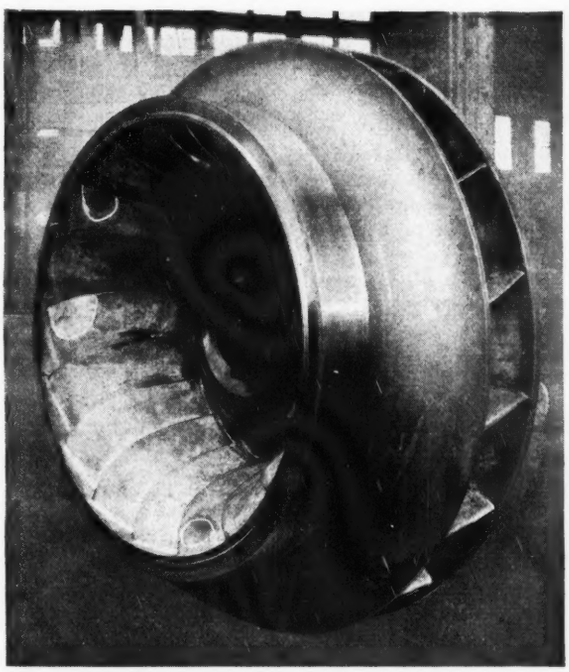


FIG. 1—ORIGINAL RUNNER AFTER 3½-YEARS' SERVICE

Three repaired areas on the runner vanes are outlined by the chalk lines, and there are one or two similar areas on the vanes not visible. Otherwise the runner is shown exactly as removed from the turbine, except for the application of a rolled-steel lower seal ring.

including the measurement of seal-ring clearances. Following the first two years of nearly uninterrupted operation the machine has been taken down once each year for an internal inspection. In addition, pressure gages have been connected at various strategic points so that the changes in clearances may be observed through their influence on the pressures in the working chambers.

The runner has shown a remarkable resistance to wear either from erosion or cavitation. The original runner was used continuously for 3.5 years, at which time it was replaced by one of somewhat greater capacity. It was in such good condition, except at the sealing surfaces, which will be discussed in detail later, that it was sent to the manufacturer's works for restoration as a spare. At that time new seal rings of rolled steel were applied to the runner and the few scattered water-worn spots were repaired by welding. A good idea of the small amount of wear on the hydraulic surfaces may be had from the repair work cost which was only $15. The original runner has been returned to the plant as a spare, for which it will be satisfactory when the second unit is installed. The latter will eliminate the need for the over-capacity of the new runner.

No work has been done on any part of the guide vanes or their operating mechanisms. The vane surfaces are in good condition, without any evidences of cutting at the seating points. Fig. 2 shows the condition of the vanes after 4.5 years of operation.

The bronze throat liner plates have given equally as good service as the guide vanes, as indicated in Figs. 2 and 3. At the present time they present a uniformly roughened surface inside of the guide vane circle of about the texture of No. 1 sand paper, but with a reduction of the surface of only a few mils. There has been no work done on the liner plates; apparently they are still good for a number of years' service.

Bronze liners for the runner balance chambers and for the draft tube immediately below the runner discharge are in good condition. The surfaces of the liners are darkened from oxidation. Cavitation appears only as a few scattered pin holes immediately below the runner, none of which is more than $\frac{1}{32}$ in. deep, and without any reduction of the general surface. These liners are practically as good as new and capable of delivering many more years of service.

As might be expected in a turbine of this character, the seal rings presented the biggest problem and the largest item of maintenance. As originally installed, the stationary seal rings were of rubber, consisting of two parallel strips vulcanized into cast-iron containers with

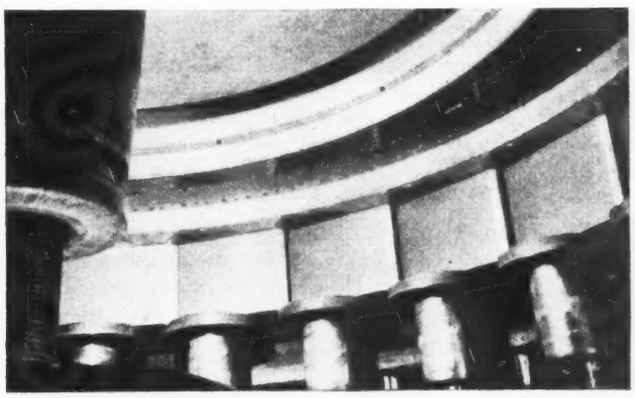


Fig. 2—Upper liner plate and guide vanes after 4½-years' service and white-brass seal rings after one years' service

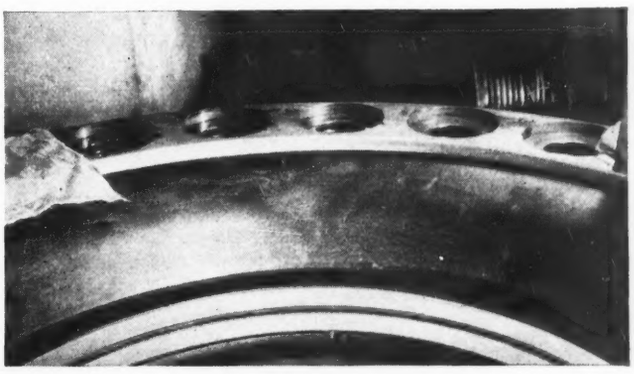


Fig. 3—Lower liner plate and chamber liner after 4½-years' service. White-brass seal rings have been in service one year

lubricating water supplied to the space between them. The rotating seal rings consisted of turned surfaces on the bronze runner casting. The rubber seal rings apparently lasted well for the first 1.5 year, when they were found so badly torn as to require replacing. New rings were installed, and about a year later it was found that the rubber was again torn out. A new set of rubber rings was made, of slightly smaller diameter, and the wearing surfaces on the runner were turned down to present smooth faces to the rubber.

Following an indication that this set of rubber rings was lasting no better than the previous ones, and as it was desired to increase the units output, it was decided to install a new runner designed to secure maximum output from the water passages and arranged with renewable steel seal rings. Cast-iron containers with inserts of Parsons white brass were chosen to form the sealing elements. The new runner and seal rings were installed and a year later when the machine was dismantled for its yearly inspection all parts were in good condition.

There was no measurable wear on either the rotating steel or stationary white brass surfaces, all being polished

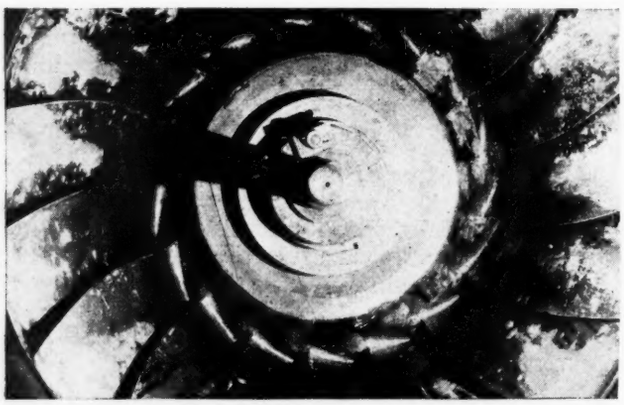


FIG. 4—APPEARANCE OF NEW RUNNER AFTER ONE-YEAR'S SERVICE

The dark areas show the original red paint applied at the time of manufacture, and the light areas where the paint has worn off, the surface of the metal being about like No. 0 sand paper.

brightly from the action of the high-velocity water. Due to slight irregularities, contact had been established at one point at the upper stationary rings and one point on the lower rings, with the corresponding rotating members. The properties of the brass to resist tearing were definitely demonstrated, as these points of contact were simply highly polished areas without evidences of scoring or tearing. All of the parts were returned to service exactly as they were found, and it is expected that next year's inspection will show equally good results.

After the first 2.5 years of operation, and for no apparent reason, a vibration appeared in the entire rotating structure. This vibration was peculiar for the reason that apparently it was not mechanical. At full speed and light load the machine ran smoothly, but at a little above half load the vibration commenced suddenly and continued with unbated violence until the load was reduced to practically zero. Vibration appeared as a horizontal whipping movement, not quite in synchronism with the rotation of the shaft, of the whole upper part of the generator structure, and the turbine shaft and guide bearing. It was known at the time that the rubber seal rings were virtually destroyed, but as this was a condition that had occurred before without objectionable results, no particular importance was attached to it.

Finally, after many futile experiments and studies, it was decided to replace the seal rings, with the thought that they might be the source of the trouble. At that time the runner was turned down and the new stationary rings installed, as mentioned in the preceding paragraph. With the reduced clearance, the machine ran smoothly, and at no time has there been the slightest recurrence of the difficulties from vibration. Since then the machine has operated smoothly at all loads and without any suggestion of vibration, either hydraulic or mechanical. No vacuum breakers are employed, and the hydraulic conditions are stable at all loads.

The main shaft stuffing box packed with the special metallic packing has given no trouble, and no packing has been added or particular attention given the gland in the more than five years of continuous operation. A check of the clearances with feeler gages at the time of the last inspection indicated that the packing was still in contact with the shaft and there was no evidence either of wear of the shaft sleeve or of tearing of the packing. It appears that a good seal is still made and that the packing is good for several more years of service.

The relief valve has worked satisfactorily and has proved invaluable in maintaining stable flow conditions in the long flow line. At one time the seat ring on the valve plunger became loose. A new plunger was ordered with a seat ring more firmly attached. Since then there has been no further difficulty.

At the turbine casing entrance the butterfly valve has given 100 per cent service and is sufficiently tight so that the turbine casing may be entered without discomfort with full pressure in the penstock.

Governor Oil-Pressure System

The governor oil pressure system has given practically no trouble, the only maintenance work of consequence being replacement of the original spur driving gears on the waterwheel-driven pump with herringbone gears to secure more quiet operation. As originally constructed, both of the pumps were manually started. As the electrically driven pump was the more efficient, it was desirable to use it continuously. However, during electrical disturbance the motor would stop and require an operator to immediately start the waterwheel-driven pump. To overcome this difficulty, the waterwheel-driven pump was used continuously for a considerable period. To secure the highest reliability from the equipment automatic control was installed for the waterwheel-driven pump, so that it would start automatically with reduction of oil level below normal working range. This permitted the electrically driven pump to be run as the normal source of supply, with the waterwheel-driven pump as stand-by to start automatically if the former stopped.

Aside from adjustments and routine maintenance work, there have been no alterations or repairs made on the governor actuator and its related parts. The governor drive, consisting of an endless leather belt connecting the main generator shaft with a light vertical shaft, on ball bearings, extending to the actuator, has proved fairly satisfactory. Belt replacement has been required on an average of not over once a year. Since the unit was installed, governor gear drives have been so improved that the second unit now being installed will be equipped with gear drive. The belt drive on the first unit may be subsequently converted to a gear type. These drives have demonstrated their ability to operate for years without difficulty or maintenance, and failure of the governor drive is thus remote.

NEW 60,000-KVA. GENERATOR FOR TESTING LABORATORY

By M. W. SMITH
Power Engineering Department
Westinghouse Electric & Manufacturing Co.

GENERATING CAPACITY in the alternating-current high-power laboratory of the Westinghouse Electric & Manufacturing Company has been increased to 100,000 kva. by the addition of a 60,000-kva. generator arranged to operate in parallel with the original plant, to allow testing the large circuit breakers demanded by modern power systems. The generator is rated at 60,000 kva., 13,200 volts, 3 phases, 60 cycles, 514 r.p.m., at temperature limitations for continuous operation. Continuous operation of this generator, however, will be required only when used as a load for making temperature tests on other large machines, and under this condition it will usually be under-excited. Normally, it will be operated as a generator to supply current for testing circuit breakers under short-circuit conditions. To deliver high currents under this condition the machine has been designed for a low value of transient reactance of approximately 7½ per cent.

To meet the latter requirement the machine is not only comparatively large for its rating, but is specially proportioned to reduce to a minimum the leakage fluxes in the armature and field. The strength of the field relative to the armature has been kept at a comparatively high value, so as to maintain inherently a high value of sustained short-circuit current. This consideration resulted in a short-circuit ratio of approximately 3½. Moreover, the exciters are designed for use with a high-speed excitation system that will increase the sustained short-circuit current considerably above the inherent value. The stored energy in the rotor is comparatively large and will therefore supply the short-circuit losses for an appreciable length of time with little loss in speed.

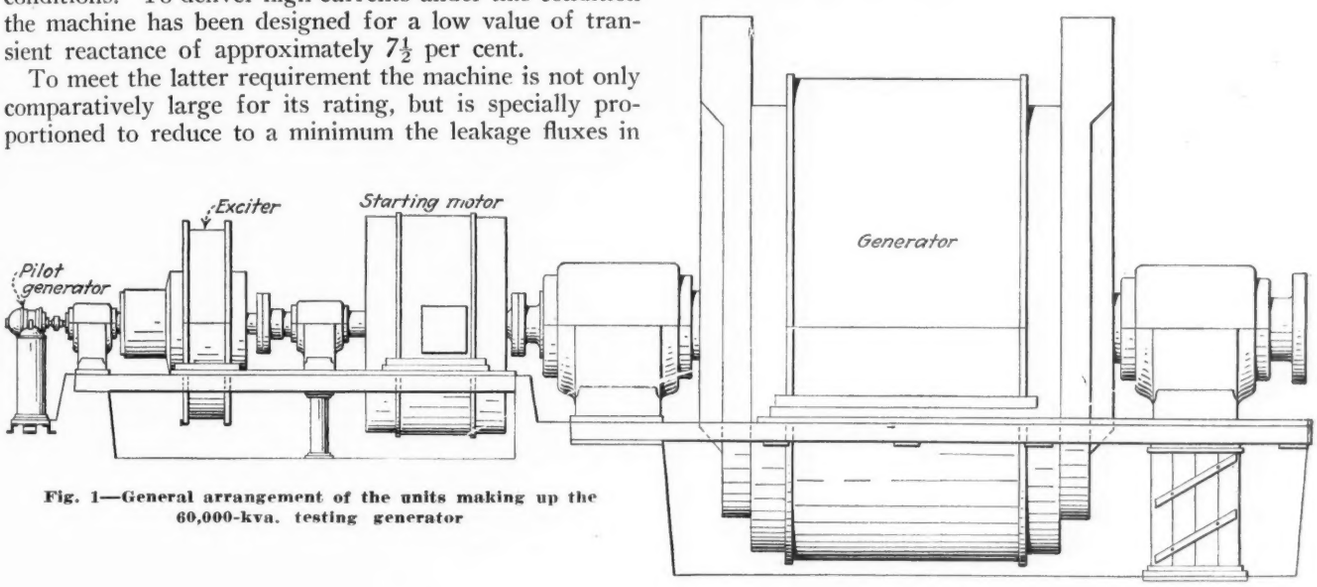


Fig. 1—General arrangement of the units making up the 60,000-kva. testing generator

Fig. 1 shows the general mechanical arrangement of the set. A 6,000-hp. induction motor adjacent to the main generator drives the unit. The pilot generator is used to determine the phase displacement between this and other sets operating in parallel during short-circuit tests. Provision has been made for future addition of a duplicate main unit, the capacity of the driving motor being adequate for two main machines. The complete set, Fig. 1, weighs considerably over a million pounds, almost 600,000 of which is in the generator's rotor. The main generator shaft is an unusually large forging, weighing 75 tons, and has a maximum diameter of 52½ in., with a diameter through the bearings of 30 inches.

Because of the losses incident to the large bearing load and high journal speed, the bearings are cooled by motor-driven pumps that circulate the lubricating oil through external water coolers.

Springs, made from special steel bars and located between the stator frame and frame feet, support the main generator and minimize the forces transmitted to the foundation during short-circuit tests or when the unit is carrying single-phase load. The springs permit the large mass of the stator to move through a small angle in a relatively short time. The machine will be subjected to as many as 3,000 short circuits a year. It would be extremely difficult to design and construct a foundation that would stand these severe conditions if the frame were not spring-mounted.

The stator frame is fabricated from steel plates, to which the armature punchings are secured by large bolts and heavy end plates. A standard diamond-type armature winding is used, with two coil sides per slot. The end windings are unusually well braced, by steel rings, spacing blocks and roping, to prevent distortion under short-circuit conditions. Twelve leads are brought out from the stator windings, so that various voltage combi-

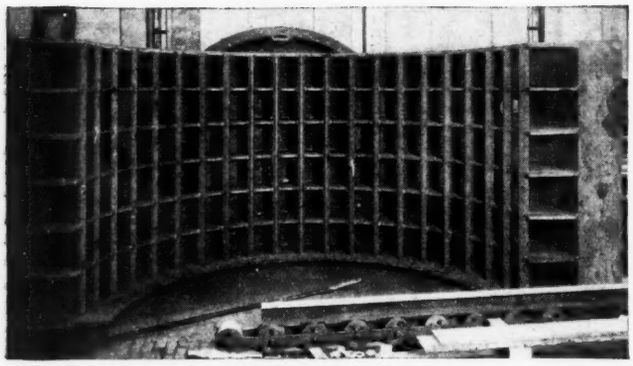


Fig. 2—One-half of the generator's frame, showing the welded fabricated construction

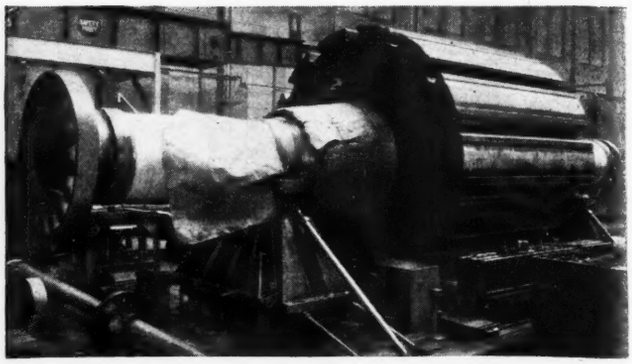


Fig. 3—Rotor core and shaft for the 60,000 kva. testing generator

nations can be obtained at both 25 and 60 cycles by series, parallel, star and delta connections.

The rotor spider is made from large rolled steel plates about 4 in. thick. The field poles are made of $\frac{1}{16}$-in.-thick punchings held between heavy steel end plates and are secured to the spider by unusually large dovetails, which are necessitated by the high speed. A peripheral speed of approximately 20,000 ft. per minute will be attained by the rotor, or over 225 miles per hour at normal speed, which approaches values commonly used on turbine-generators. A centrifugal pull of about 6,000,000 lb. will be exerted on each pole. The restraining force of the spider to hold all the poles and coils is approximately 84,000,000 lb. The total force acting on the spider, including the centrifugal force due to its own weights, is about 180,000,000 lb. A heavy low-resistance welded-type damper winding on the rotor will permit of operating at large single-phase loads and will improve the voltage wave form under single-phase loads, either for continuous operation or for short-circuit conditions.

▼ ▼ ▼

Lubricating Oil Causes Engine to Overspeed

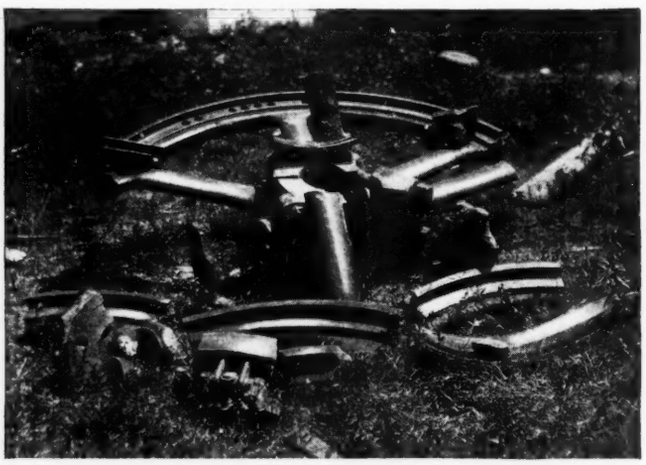
By ORVILLE ADAMS

THE BROKEN FLYWHEEL shown in the illustration resulted from the overspeeding of a crankcase compression oil engine. The overspeeding was ascribed to lubricating oil in the crankcase which mixed with the air charge and entered the cylinder.

The engine was totally wrecked, as was some of the mill machinery. While no one was killed, the damage to the mill and a near-by house was large.

A great many engines of this type have no filtering equipment for lubricating oil, and, consequently, no pump to remove the oil from the crankcase, depending upon gravity drainage. If sludge accumulates and the crankcase is not kept clean, which will happen in worn engines experencing blow-by of the gas past the pistons, there are possibilities that oil will accumulate in the crankcase in a short time. In cold weather the lubricating oil, already viscous, may refuse to flow through even a comparatively free drain pipe. This, of course, results in accumulation of oil in the crankcase, even though the compression in the crankcase exerts pressure that tends to blow the oil out the drain pipes.

When, for any reason, the lubricating oil so accumulates that the end of the rod strikes the surface, the oil is churned into a mist, which, of course, is carried into the cylinder by the intake air. The engine governor has no control over the oil-charged air. Lubricating oil when mixed with the air burns as readily as fuel oil. The faster the engine runs, the more the condition is aggravated, and the remaining oil in the crankcase is whipped into a fine mist and more of it is taken in at each stroke. In a few seconds the speed may reach an exceedingly high point, resulting in a flywheel rim speed several times higher than the wheel was designed for as in the case cited above.



Too much lubricating oil in the crankcase resulted in a runaway engine with a badly damaged flywheel, to the embarrassment of all concerned

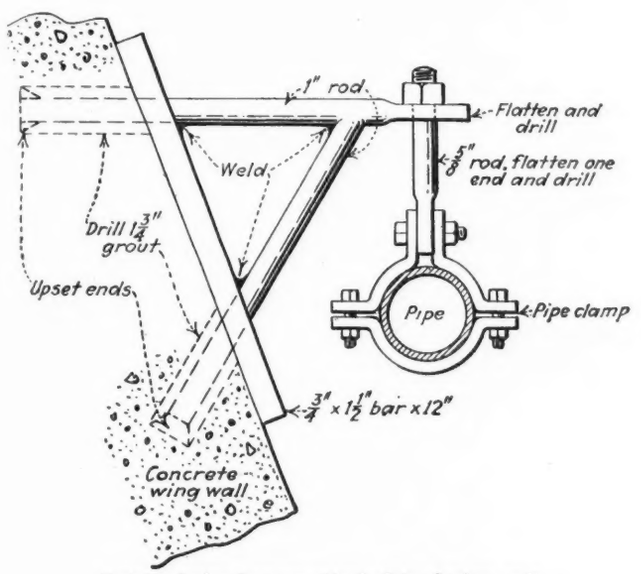
▼

. . . RIGHT OUT OF THE PLANT . . .

Pipe Hanger for Sloping Wall

HAVING OCCASION to hang a steam line on the inside of a fire wall with sloping buttresses, the type of hanger shown in the illustration was used.

Two 1¾-in.-diameter holes were drilled in the concrete, as shown. The bracket was made from two pieces of 1-in. round rod and a flat bar base plate of ¾ x 1½. One end of each of the round bars was upset and the other end of the horizontal bar was flattened and drilled to take a ⅝-in. bolt. The holes in the base plate were



Detail of pipe hanger attached to sloping wall

burned in with a torch to correspond with the holes in the concrete. Then the two 1-in. rods were grouted into the holes with the base plate in place, the whole being later weldd, as indicated, to form a strong rigid bracket.

The pipe was suspended by a two-piece clamp and ⅝-in. rod, as shown. These ⅝-in. rods allowed for endwise expansion, as the hole in the top rod was made oversize. We had a run of 150 ft. of 4-in. steam line along the fire wall all supported in this manner.

Long Beach, Calif. M. C. COCKSHOTT.

Causes of Pounding in Engines

A SKILLFUL operating engineer can detect irregularities in the performance of an engine that would be imperceptible to the unpracticed. Derangements of the parts of an engine nearly always give timely notice by some abnormal sound, but owing to the difficulty in locating the source, the cause of the pounding is not always easy to determine.

Looseness of journal boxes is the most frequent cause of pounding, which generally occurs as the crank passes the centers. If the boxes are slack the pounding may heat the journal. This is especially true of crankpins. Stopping the engine and setting up the brasses usually will remedy a pounding crank. But the adjustment should be made gradually. The brasses may have become worn until their ends are in contact, so that they cannot be set up, in which case the ends should be filed down to permit of proper adjustment. Calipering the pin and transferring the measurement to a pair of inside calipers, with which to measure the bore of the brasses, is the correct way to determine the amount to be filed off. It is good practice to file off enough to give an opening between the brasses, when they are in place, of from ⅛ to $\frac{3}{16}$ in. The opening may be filled with thin liners. Then when the brasses become loose on the pin they can be slackened and a pair of the liners removed. The boxes of shaft journals may be set up without stopping the engine, provided they are safely accessible to the operator.

Pounding in the cylinder may be due to a loose piston or to slugs of water entering the cylinder with the steam. Piston-rod nuts seldom work loose, because of the general practice of putting a cotter pin through the rod end behind the nut, or a set-screw through the nut. Priming of the boilers is the usual cause of water entering an engine cylinder. When this occurs the cylinder cocks should be opened and should be left open until the priming is checked. If operating conditions permit, the priming may be allayed by closing the throttle just enough to diminish the speed of the engine slightly for five or ten minutes.

Pounding may be caused by the piston's striking the cylinder head. This often occurs in old engines in which the connecting-rod brasses have worn down. The connecting rod may be so designed that keying up the brasses has the effect of lengthening or shortening the rod. The remedy is to restore the normal length of the rod by inserting sheet-metal liners behind the brasses. The piston may strike the cylinder head by reason of the piston rod's unscrewing from the crosshead. The rod backs out gradually, so that a long interval elapses before it is out far enough for the piston to make disastrous contact with the head. Ample warning thus is given.

A frequent cause of pounding not so easily recognized as the foregoing is improper setting of the valves, producing insufficient compression or insufficient lead, cut off at a point too early in the piston's stroke, and release too late. Reducing the compression invites

pounding; but too much compression puts too great a resistance against the crank, tending to cause unsteadiness in the crank's velocity. Insufficient lead is a common cause of pounding. The exact amount of lead necessary to prevent pounding can be determined only by trial. Generally, high-speed engines require more lead than those of slow or medium speed.

With insufficient lead, the piston is brought to rest with a jerk. A similar effect is produced when the release is late. The ideal condition is when the pressure is the same on both faces of the piston at a point in the stroke just in advance of the opening of the steam valve. This point is determined by the speed of the piston and by certain conditions which only the indicator can reveal. Pounding in a condensing engine may be due to a high vacuum's not allowing sufficient cushion for the piston. A. J. DIXON.

St. Louis, Mo.

Who Should Operate Electrical Equipment?

THE PRACTICE of allowing just any one around the plant to operate electrical equipment, change fuses and make general repairs is to be condemned.

One plant was operating in this way, believing that they were saving on labor in the electrical department. But by going over a few of the troubles experienced in cost, accidents and equipment delays, the fallacy of such belief is soon revealed.

Machine hands, when stopping their machines, especially at quitting time, are usually in a hurry. This puts them in the right mood for forgetting or overlooking some seemingly unimportant detail.

One Sunday morning a machine was being shut down that was driven by a 50-hp. slip-ring motor located in the basement. The workman who stopped the motor merely pulled the drum controller handle to the off position and failed to trip the oil switch. This cut sufficient resistance into the rotor circuit to stop the motor, with the power on the stator.

The motor remained in this condition all day and before the trouble was discovered the windings were roasted and had to be replaced.

Another case was that of a 75-hp. starting compensator. A workman starting the motor threw the starter to the running position before the motor came up to speed. This raised the relay and the starter would not catch in the running position. The starter was then tied in the starting position, burning out the transformer coils.

The workman responsible was honest and talked freely about the matter. When asked why he didn't tie the starter in the running position if he must tie it in at all, his reply was that it was easier to tie it in the starting position, because the handle came close to the pipe rack supporting the starter.

Many other equipment delays are caused by throwing large motors across the line, and by not giving others time to come up to speed on reduced voltage. The oil switch for starting slip-ring motors is often closed with the controller handle in the running position. Both practices often trip the main oil switch, shutting down several machines.

There are altogether too many motor bearings burned out by reason of too tight a belt. It is difficult for an experienced motor man to know just what belt tension a bearing will stand. His only sure procedure is to watch it carefully for a while after each take-up. But why intrust this responsibility to a machine operator unacquainted with motor operation, and who will, in most cases, not have the necessary time to do the job, much less watch it afterward.

Where operation is left entirely to machine operators, the jack-of-all-trades soon appears. He has seen others change fuses and make minor repairs. Shortly he discovers a small job that he thinks isn't necessary to call the proper authority to make the repair. So he goes at it himself, as one workman did:

One day his motor refused to start. He opened the switch door and found that a wire had come loose from a terminal. Thinking that the repair could be made by clamping the wire under the nut holding the terminal, he attempted to do it without pulling the switch. The repair ended in a short circuit's burning the workman about the hands and face.

Another workman had seen the electrician test fuses with a lamp bank. One night he wanted to test some fuses. He procured a single lamp socket and a 110-volt lamp and applied it to a 500-volt circuit. The result was a short circuit that shut down the entire plant. The man spent several weeks in a hospital.

Some will say that these mishaps were due to carelessness, improper instruction, poorly maintained electrical equipment and wrong type of workman. But these mishaps occurred in plants with the same type of workman, same type of equipment and instruction as those of any other plant, which proves that electrical equipment operation should be left to electrical workers.

Of course, every machine operator should be well informed as to how to safely stop his machine in an emergency. On the other hand, where a workman stays on the job year after year he can surely be taught to start his own machine properly and safely. But it is practically impossible to properly train and instruct the workman who is here today and gone tomorrow.

When operation is left to the electrical department, a finger is ever on the pulse of the production machinery drives, resulting in practically no delays and minimum repairs.

The experienced operator will see things and interpret noises that are signs of impending trouble which the inexperienced operator will not notice.

Electrical equipment requires frequent inspection for best operation. The inspections are greatly augmented when the electrical department takes care of most of the starting and stopping of motors. MARIN PHILLIPS.

Niagara Falls, N. Y.

Restoring a Dynamo's Residual Magnetism

THE electric-generating equipment installed in the basement of a manufacturing building consisted of a pair of direct-current, compound-wound dynamos directly connected to high-speed engines. These units were run week about. Only occasionally, and then for but brief intervals, were both of them needed to supply the load. One day the oiling system on the engine in operation failed and it was necessary to get the other unit into service in a hurry. But when the reserve engine was brought up to speed the connected dynamo refused to generate. The pilot lamp on the switchboard flickered

for an instant and went dead, while the needle of the voltmeter budged not at all.

After testing the fuses and finding everything else intact, the engineer concluded that the machine had lost its residual magnetism. But he did not know how it could have done so. During its idle period the machine had been given a limited overhauling, which consisted principally of turning up the commutator by means of a portable turning rig bolted to the field yoke.

The engineer knew that the residual magnetism of a direct-current generator can be restored, or reversed if needs be, by sending a current through the magnetizing coils from an outside source. This he proceeded to do. He lifted all the brushes from the commutator, so as to avoid short circuiting the armature, and then he closed the equalizer and line switch. Thus he put the shunt winding of the dead machine in circuit with the busbars and so restored the residual magnetism. Only a few seconds were consumed in accomplishing the trick. When the generator was again put in motion, after the switch had been opened and the brushes dropped back into place, the voltage promptly built up.

St. Louis, Mo. D. J. ALLISON.

Orifices for Building Heating Control

IN THE Oct. 7 number of *Power* I read with considerable interest an article by L. K. Ferris, on the use of orifices in heating systems. From personal observations I have found that a tremendous amount of heat is wasted, especially in larger office buildings and in public buildings. Where the occupant of a building has to pay his own heat bill, he probably closes the radiator valve when the room gets too hot. But where he pays indirectly, the radiator is allowed to run full blast, with the windows wide open.

Especially in public buildings, it seems that the occupant has an idea that steam is produced without cost. Any system, therefore, which will force the occupant of such a building to save heat would be welcome.

The use of orifices in steam inlet connections is no doubt one way of conserving steam; and the use of orifices in conjunction with a differential vacuum system would be better still. By controlling not only the flow of steam to each radiator by orifices, but also by controlling the quality of this steam, the desire of an occupant to open the window rather than close the radiator valve would be somewhat lessened.

It is my opinion that the final aim in heating, especially public or office buildings, where the occupant is only indirectly concerned with saving of heat, will be to remove all valves from radiators, that is, such valves as are controlled by the occupant, and to give the room a definite amount of heat, fluctuating according to the outside temperature, and out of control of the occupant.

In analyzing different systems now available the so-called differential vacuum system would appear to come nearest such a goal. Room control, whether by means of compressed air or individual temperature-controlled radiator valves, will not solve the problem; besides, such an arrangement is rather costly. But to control the amount of heat delivered to the radiators by controlling the pressure or vacuum in the supply lines or on the boiler will partly solve the problem.

It seems to me, however, that this system is not the final. With the differential vacuum system, steam pressure in supply lines, and sometimes on the boiler, will generally be below atmospheric. Outside of the difficulty most steam fitters have to make a piping system tight against in-flow of air, the pipe sizes will have to be comparatively large.

Why not take advantage of possible steam pressures and distribute steam to radiators at the highest practicable pressure, to be reduced at each radiator inlet to the low value desired.

Assume that steam is generated and distributed to radiators at, say, 15 lb. pressure for a low-pressure installation; reduce this pressure a predetermined amount before steam enters the radiator, the pressure drop being constant under all conditions of pressure on supply line. A simple valve (not touched by occupant) may be designed to allow a definite pressure drop. A standard check valve with the addition of a spring on the top of the seat will allow the disired differential. Assume that this valve will be adjusted to drop the pressure 10 lb. on steam flowing through. With 15 lb. on the supply line, the pressure on the radiator, once it is filled with steam, will be 5 lb. By lowering the steam pressure to 10 lb. the radiator pressure will automatically drop to 0 lb., and in vacuum systems we may continue and reduce the radiator pressure to equal the vacuum conditions in return lines. By graduating the pressure on steam main either automatically through thermostatic arrangement, or manually, as needed by weather conditions, the heat output of radiators will be adjusted to suit these conditions, and, at the same time, pressure on supply mains will at all times be above atmospheric. The cost of installation will be reduced, and the possibilities of air leaks into the system will be minimized.

It will also be possible to separate into zones if required, or in some rooms where more heat is needed the inlet valve may be adjusted to give less pressure drop. Individual needs may be taken care of, and radiators that may prove too large or too small may be adjusted to normal by changing the pressure drop through the inlet valves. The inlet valve may be inserted in the first section of the radiator, and may be a part of this radiator, thus allowing a close connection with a minimum space wasted.

With a good thermostatic trap, the pressure in a radiator, once it is filled with steam, will be approximately the same as the pressure at the inlet, irrespective of the pressure conditions in the return, and a definite amount below the pressure in the main supply lines. If the room temperature should drop, the condensation in the radiator will increase with the resultant lower pressure. With this reduction of pressure the differential will increase, automatically opening the inlet valve. On the other hand, with decreased demand for heat less condensation will occur with less pressure differential and automatic closing of inlet valve. This arrangement will, therefore, to a certain extent, take care of the room temperature without the use of temperature control valves.

As a summary, I should like to propose a system that would result in: (*a*) distribution of steam at considerably higher pressure than heretofore customary; (*b*) reduction of pressure a definite amount at radiators; (*c*) control of steam pressure in mains to suit heat demands.

Old systems with too small pipes to allow extensions may be used by increasing the steam pressure and changing present valves to differential pressure valves.

B. F. RANDEL, *Mechanical Engineer*,
San Diego, Calif. Navy Public Works Office.

From Among Readers' Problems

Conducted by
L. H. MORRISON

MANUFACTURE OF LUBRICATING OIL —*We have two oils both of which are from a paraffine crude. They test as follows: No. 1—Gravity, A.P.I., 29; flash, O.C., deg. F, 355; fire, O.C., deg. F, 410; viscosity, S.U.V., sec. 100; pour test, deg. F, 32. No. 2—Gravity, A.P.I., 28; flash, O.C., deg. F, 360; fire, O.C., deg. F, 420; viscosity, S.U.V., sec. 105; pour test, deg. F, 35.*

No. 1 is a clay-filtered oil and No. 2 is an acid sulphuric-treated oil. Can you tell me what clay filtered and acid treatment oils mean and the process the oil goes through? Which process costs the most? T.W.L.

The oils described are derived from what are known as paraffin crudes. The usual practice in handling such crude oils is to subject them to distillation, removing gasoline, kerosene, gas oil, wax distillate and a heavy cylinder-stock distillate. The wax distillate is a very broad low-viscosity fraction, contains crystalline wax, up to 20 per cent; in modern practice the wax distillate is cooled by refrigeration and passed through a filter press at a very low temperature, —15 to —20 deg. F., to remove the wax. The wax-free oil is next agitated with sulphuric acid to remove impurities from the oil.

Upon settling out and removal of the acid-sludge formed, the oil is neutralized with caustic soda and finally washed with water. The next step consists in distilling the oil. This operation gives light, or low-viscosity, distillates and a residual oil which is left in the still. The residual oil is cooled and then percolated through Fuller's earth to remove the coloring matter in the oil. Since the wax distillate contains light, medium and heavy fractions of lubricating oils, the reduction process is necessarily guided by the quality, or the viscosity, of the finished reduced oil desired. For a heavier product the reduction, that is, the removal of the lighter products by distillation, is carried somewhat farther than if a lighter final product is wanted. This naturally is governed by the demand for the product, and is also influenced by the character of the wax distillate. Wax distillates obtained from one crude oil may contain a different amount of, say, 300-viscosity oil than a wax distillate from a crude originating in another part of the country.

The distillates obtained in the reduction process may be segregated as the temperature in the still is raised, giving low-viscosity oils which, after percolation through Fuller's earth, may be utilized as very light lubricating oils; or the distillates may be all mixed together and then cracked for the production of gasoline.

In some cases the finished oils do not receive the final percolation through Fuller's earth.

Where the distillate receives no acid treatment the reduced oil is merely percolated through Fuller's earth.

The question of costs is complicated by crude oil prices, the quality of the crude and the equipment on hand in the refinery; so no absolute answer may be given.

Percolation through Fuller's earth is being superseded by what is known as "contact clay treatment," which consists of mixing the oil with finely ground absorbent clays, either used as obtained from the natural deposits or activated by chemical treatment, heating rapidly to the desired temperature, cooling and filtering through a filter press. The method is more economical in many cases than the older Fuller's earth percolation. Clay contacting is applied directly after the acid treatment and so eliminates the caustic soda treatment, the water wash and the Fuller's earth percolation.

PREVIOUS QUESTION
Discussed by Readers

THE QUESTION

I FIND on taking charge of a heating system that a water spray is used ahead of the vacuum pump. Is this good practice and why is the spray necessary? R.R.C.

THE SOMEWHAT common but improper use of water spray in the return line ahead of a vacuum pump is to reduce the temperature of the returns and condense steam in the line to enable the vacuum pump to maintain the proper system vacuum. This condition might be caused by any one or all of the following system conditions: leaking radiator return line traps; leaking main line drip traps; risers improperly trapped or not trapped at all, causing short circuiting of the steam to the return line and by steam caused by re-evaporation of the direct discharge into the return line of high-pressure steam traps.

The most economical way to reduce the return line temperature is to prevent bypassing of steam through leaking radiator traps and riser traps. All riser and main line drips can be taken care of through either a heavy-duty float-type trap or sylphon trap. High-pressure steam trap discharges should be passed through a heavy-duty float-type trap before discharging into the return line; this heavy-duty trap should be properly vented to the low side of the system so that the heat of re-evaporation is not lost but is utilized for radiation. The system in question might require entire revamping, but the saving of fuel and results obtained over a certain period would warrant it.

JAMES T. MCCALEEY.
Palmer, Mass.

WATER SPRAYS are often installed in heating system return lines ahead of the vacuum pump to assist the pump in creating the necessary vacuum. These sprays decrease the volume of the flash steam by condensation, thus inducing a part vacuum. It may be found in some cases, as happened to me, that the operators will insist that these sprays are necessary to operate the return pump satisfactorily. Their assertion, however, proved to be wrong as we were able to obtain much better results without the sprays after we had thoroughly checked the system for air leaks or traps blowing through. At no time

afterward was it necessary to introduce any water sprays in the return lines.

If the vacuum pump discharges directly to the feed-water heater and the amount of cold water spray plus the system returns is not in excess of the boiler feed requirements, I see no particular reason why this practice should be objectionable.

However, if the heating system itself is tight, with no pump, trap, or fitting leaks, the vacuum pump should be able to give satisfactory performance without the aid of water sprays.

I suggest that a thorough check be made of the system to determine any possibility of leaks, with the idea of operating the system without the use of the water sprays. G. F. MAYELL.

Chicago, Ill.

IF I WERE to take charge of a heating system and found a water spray open ahead of the pump, I should first check over the entire system, examine all traps to find out whether any are blowing through and if so repair them or get new traps. Also I should look for open bypasses or any other way that steam could blow into the return line. After doing this the return temperature should drop enough to allow the pump to handle the returns and pull a good vacuum. An open spray indicates an inefficient system and should be put in shape as soon as possible.

Little Rock, Ark. J. V. STANG.

SPRAYING cold water into the main return pipe close to the vacuum pump for the purpose of condensing any steam in it is not common practice. Such a method may have a few points favoring it; but these points are of less consideration when the troublesome steam is kept out of the return line or cooling coil radiation installed where required. Waste of steam and water, in conjunction with this water spray is sufficient to discourage the use of this method.

The use of a water spray in a vacuum line system is usually installed to cool an excessively hot vacuum pump so that the degree of vacuum at the pump may be increased, although the loss of condensate in some other operation may be replenished in this way. When the cause of this excessive heat of the vacuum pump is corrected by replacing worn, broken or obsolete and inoperative return traps, repairing air leaks throughout the system, checking the depth of any loop seals against the effective pressure on them (an unsuspected cause of overheated return lines) and installing, wherever required and possible, cooling coil radiation across return lines into which hot condensate discharges and flashes, the use of the water spray may be eliminated.

If extreme conditions demand a cooler vacuum pump, as when a large amount of liberated condensate re-evaporates from periodical discharges from traps of radiation that are very close to the vacuum pump, the use of this cold water spray effects the rapid condensation of the flash steam and permits the vacuum in remote parts of the system to remain fairly constant. In this case, and to overcome similar conditions, a water spray is justified, and if under automatic control all the better.

Improvements in the design and construction of return traps, with a view to making them more sensitive and rugged, are being made rapidly, and with the advent of orifices and adjustable-port discharge radiator valves fast making claims for equal distribution of steam, so that the proper allotment of steam to each radiator may be proportioned to suit the varying weather conditions, there is a certain conviction that these developments will play an important part in future operation of vacuum pumps without the use of a spray of "jet water." WILLIAM ANDERSON.

Brooklyn, N. Y.

IN A PROPERLY designed and installed vacuum system, a water spray ahead of the vacuum pump should not be necessary.

The object of the spray, usually, is to condense as much of the steam as possible and thus improve the vacuum. However, considering the effect of the spray from another angle, we find that air entrained in the spray water will liberate itself upon the water's becoming heated, thus increasing the amount of air to be removed by the vacuum pump. This air will also expand into the vacuum and partly neutralize the effect of the spray. In case the make-up water is introduced into the system at this point, to be heated, it would be better practice to run it through a separate feed-water heater, in which it would get hotter, and the elimination of the air would not interfer with the vacuum.

A surplus amount of available boiler feed water is often the result of a spray installed to condense an excessive amount of steam ahead of the vacuum pump; which may be caused from traps in bad condition or by steam from some other source entering the return line.

If this surplus of heated water so gained must be wasted to the sewer, the resulting loss is obvious.

F. W. HALTER.

Minneapolis, Minn.

A Question for Our Readers

HOW much acidity can I allow in the oil used for lubricating our 2,000-kw. impulse turbine without danger of corrosion or sludging? H.E.M.

Suitable answers from readers will be paid for and published in the Jan. 6, 1931, number

SPRAY VALVES are used ahead of the vacuum pumps in many heating plants to prevent the pumps becoming vapor bound. They are a necessary piece of equipment where the return lines are short and the condensate reaches the pump at high temperature. There are several efficient automatic spray valves on the market. Many are of the spring-loaded diaphragm type and may be so adjusted as to inject cold water into the return line whenever the vacuum drops an inch or so below the desired amount. The operation is as follows:

A vacuum pump working on a return line system maintains a 5-in. vacuum. Should some of the traps in the system be defective and pass live steam to the system, or should the condensate reach the pump at around 200 deg., the vapor produced will tend to bind the pump, which, in turn, will cause a drop in vacuum. When the vacuum has dropped to the point at which the spray valve is set, say 4 in., the valve will operate and inject a spray of cold water into the return lines, which will condense the vapor and permit the pump to establish the necessary 5-in. vacuum again, at which point the spray valve will automatically close.

In the hospital in which I am employed the spray valve was very essential when the institution was small and the buildings were all close to the plant, but with the addition of many buildings, some at great distances from the plant, the condensate returning through the several thousand feet of uninsulated return pipe is so low in temperature that the spray valve is now of little use.

One point to remember is that a loss of vacuum due to air leaks will also operate the spray valve, but with no benefits. A. C. MCHUGH.

Norwalk, Calif.

IN MANY heating systems a vacuum pump is used to remove the air and condensation from the return lines and to force the hot water to a tank from which it may be drawn for re-use in the boiler. Such systems operate with a vacuum of 1 to 10 in. mercury in the return lines (from the radiator traps to the vacuum pump suction). As water boils at a temperature of approximately 203 deg. F. under a 5-in. vacuum, when water leaves the radiator trap of a temperature above 203 deg. part of it will flash into steam.

Steam will always be visible coming out the air discharge of the vacuum pump unless cold water is added or the return lines are bare and permit enough radiation to lower the temperature of the hot water returns considerably.

We have such a system in our plant and find that some steam is wasted at a hot water temperature at the pump suction of even 180 deg. with a vacuum of 8 in.

The practice of adding cold water is good, but I suggest that you reduce the volume of spray to where steam just becomes visible at the air discharges.

Danbury, Conn. S. PAGE.

OPERATING PROBLEMS

Feature Southern A. I. E. E. Meeting

Design and operation of turbine generators cooled with hydrogen gas; the results of short-circuit tests made on a large power system under normal-load conditions to ascertain the operating characteristics of the system and the turbine governors during system disturbances; and power transformer noise and how it may be overcome were some of the subjects given attention

WITH the Brown Hotel, Louisville, Ky., as headquarters, the Southern District of the American Institute of Electrical Engineers held a four-day convention from Nov. 19 to 22. In addition to hearing a number of papers descriptive of steam and hydro-electric power stations in the southern district, those attending the convention had the opportunity of visiting several of the interesting plants. Among the plants visited was Lock No. 7 on the Kentucky River, which is supported on high piers above the dam; the Falls of the Ohio plant, which is designed to utilize an extremely variable head; and the Dixie River plant with its large rock-filled dam.

The technical sessions included such features as industrial electric power applications; transmission and distribution problems; protective devices; transformers; application of hydrogen cooling to turbine-driven generators; the effects of load surges on steam turbine governor operation and other subjects of interest to power engineers.

THE PAPER, "Application of Hydrogen Cooling to Turbine Generators," by M. D. Ross, was of particular interest and described the application of this system of cooling to machines that are now in service. Two 7,500-kva., 3,600-r.p.m. generators with hydrogen cooling have been built and tested and one has been in operation for several months. With the development of suitable sealing glands and control apparatus to the point where reliable operation can be expected over long periods, it is the author's opinion that the use of hydrogen cooling for turbine-generators appears to be desirable at the present time in ratings of 30,000 kw. and above.

The advantages of hydrogen cooling were given as:

1. Windage losses are reduced to about 10 per cent of their value in air with a gas mixture containing 97 per cent of hydrogen by volume. The efficiency of large turbine-generators would be improved 0.6 to 1 per cent at full load, 1.2 to 2 per cent at half load, with hydrogen cooling, depending on the size and type of ventilation of the machine.

2. With hydrogen the temperature rise of the gas when passing through the machine is lower than with air, due to the lower losses to be absorbed. The surface temperature differences are considerably reduced with hydrogen, and the thermal drops, through insulation where air pockets are present, are lower than with air. For a given amount of active materials the rating of the generator with hydrogen cooling is at least 25 per cent greater than the rating available with air cooling.

3. Corona has little, if any, effect on insulation in an atmosphere of hydrogen. Insulation operating in hydrogen should therefore have a much longer life than in air. The windings also remain free from dirt, a condition which is difficult to obtain in air-cooled machines, even where recirculation of the cooling air is used, as there is always some leakage of air at the shafts and around the duct work.

4. Fires cannot occur in the generator, due to the absence of oxygen. No special fire protection apparatus is required with a hydrogen-cooled generator.

5. Due to the better heat transfer and the lower total losses with hydrogen, the gas coolers are smaller and require less cooling water as compared with an air-cooled machine.

(An abstract of this paper will be published in a later number of *Power*.)

ANOTHER paper of unusual interest was "Governor Performance During System Disturbances," by R. C. Buell, R. J. Caughey, E. M. Hunter and V. M. Marquis. This paper describes short-circuit tests made on two 50,000-kw. single-cylinder reheat-type turbines at the Stanton plant during the lightning seasons of 1928 and 1929, to investigate the operation of a turbine when system disturbances occur. Particular attention was given to the cause of trouble evidenced by overspeeding and consequent tripping of the emergency overspeed governor. The plant is located at Pittston, Pa., and is jointly owned by the Scranton Electric Company and the Pennsylvania Power & Light Company.

The results shed additional light on some phenomena which have occurred during system disturbances, and led to the following conclusions:

1. It is possible for a generator to lose synchronism and pull back in again without giving any conclusive evidence in the control room or at the turbine that such a change has occurred. Graphic charts and indicating instruments are not fast enough to indicate out-of-synchronism conditions reliably. Thus this condition occurs far oftener than has been generally appreciated.

2. Cases of sustained system oscillation, or surging, seldom occur unless some generator, or group of generators, loses synchronism. Any oscillation resulting from a disturbance that is not sufficiently severe to cause loss of synchronism quickly dies out, due to the inherent system damping.

3. Governor properly designed and adjusted will not contribute to any system oscillation as long as synchronism is maintained. When out of synchronism, however, the governor attempts to follow the speed change as the generator slips poles, and the result is a "pumping" phenomenon familiar to many station operators. This pumping action is a result rather than a cause of a sustained oscillation and is to be expected when the generator and the system are out of step at a certain slip frequency. It will cease if the generator pulls back into synchronism.

4. The speed of the turbine when out of synchronism is determined by the regulation of the governor and the induction-generator characteristics of the generator. The average output during this period may be an appreciable portion of the output before loss of synchronism.

5. In these tests the short circuits resulted in considerable reduction in the kilowatt output of the generators with consequent overspeeding and loss of synchronism. Special valve equipment for quick reduction of steam input following a sudden drop in generator output will increase the stability limits. Under certain conditions it may be of considerable benefit in maintaining stability, but under other conditions the equivalent improvement in stability may be better obtained by other means. Special valve equipment will vary in complexity with the size and type of the turbine and may be considered inadvisable for certain types. Its application to existing turbines may require

a redesign of the valve controlling mechanism and the oil pressure system to get the necessary valve closing time of one-third to one-fourth of the time at present required for normal governor operation. This equipment performs a function entirely different from that of the turbine speed governor and is not to be considered as a necessary adjunct to it.

THE "Ohio Falls Hydro-Electric Station at Louisville, Kentucky," was the title of a paper by R. M. Stanley and E. D. Wood, that described this plant. The development is a low-head, run-of-river plant and a combined navigation and power dam, the latter, a part of the United States Government's Ohio River canalization project. Eight units, with a total installed capacity of 105,000 hp., operate on a maximum head of 37 ft. and deliver power to the systems of the Louisville Gas & Electric Company. Several novel electrical features are embodied in the design of this plant. Both automatic and supervisory control equipment are employed and are housed in closed steel cabinets. A miniature switchboard with complete control and supervision of each unit on a panel 4-in. wide is another new idea that is used in station control.

There has been a considerable saving in both time and labor costs in operating the Ohio Falls hydro station, resulting from the use of automatic control equipment.

ONLY ONE switchboard operator is required on a shift. To bring a unit in on the line he turns a control key; thereafter the automatic equipment functions to start auxiliary motors, release brakes, open water gates, apply excitation and synchronize the unit on the bus. It is estimated that these automatic features have effected a yearly saving equivalent to two operators' salaries. There has also been a saving in the number of hydraulic operators needed at this station. Several factors account for this saving, simplicity and flexibility of operation, general arrangement of equipment and the complete use of automatic protective equipment, which in particular has proved to be dependable. Where three hydraulic men per shift are used for the operation of the eight generators, five men per shift would have been required without the automatic features.

Maintenance costs on this station have been somewhat lower than were at first expected. It is believed that the use of automatic equipment has resulted in less maintenance rather than more. Once the equipment is properly adjusted, routine tests and inspection have been the smallest maintenance item. Tests are conducted weekly and require only the part time of one maintenance electrician.

The miniature switchboard will permit further economies and may be located in a future adjacent steam station, in which case one operator can control both stations.

Considerable attention has been given to the reduction of unnecessary noise emitted by electrical machinery. Robert B. George in his paper "Power Transformer Noise, Its Characteristics and Reduction," described an investigation made to determine the different force components and other causes of transformer hum. Vibration amplitude and frequency measurements were made on the tank surface of a number of representative sizes of completely assembled transformers at no load and at different voltages. Surface vibration measurements were made on transformer parts to determine the sources of noise in transformers and how these noise sources are affected by variations in operating conditions. Noise surveys were made to measure the range of intensities, the frequency characteristics and distribution of sound from transformers in service. The effects of substation acoustics on noise distribution were investigated.

The intensity of the sound varies with the different designs of transformers, but it was found that as a general proposition 10 per cent change in primary voltage at no load causes a 30 per cent change in sound intensity. Amplitudes of vibrations measured at four representative points at different elevations on the side of a large transformer showed that they vary approximately as the square of the load current.

On account of the very nature of a transformer, it will always have some hum, but this hum can be reduced for operation near hospitals or in residential districts. Part of the noise can be eliminated by adding refinements at a slight increase in cost. Each further reduction in noise is obtained at the expense of more material and additional cost. The conditions are similar to obtaining high efficiencies, first by refinements to reduce the stray losses and finally by working the materials at lower densities to obtain an economical balance between the additional cost and the value of reduced losses.

THESE and other investigations also indicate that the sound intensities are not equal in all directions from the transformer. Reflections from local objects near the substation cause wide differences in intensity at different points near a transformer, although at equal distances from the tank wall. The acoustic conditions at the substation can make a relatively quiet transformer appear to be noisy. For example, two converging walls or a corner can give directional effects similar to a megaphone. Some foundations, walls or objects can act as sounding boards. Oil lines, conduits, or, particularly, sheet metal parts at the installation, may have resonant frequencies that may cause them to emit noise.

If sufficient area is used to prevent crushing, cork pads are effective under transformer tanks in indoor vaults. Arbors, hedges, shrubbery and trees are very effective for absorbing sound from outdoor substations.

Star-Connected transformers under certain conditions give rise to abnormal voltage from line to the neutral. The causes of these phenomena were given by C. W. La Pierre in a paper "Theory of Abnormal Line-to-Neutral Transformer Voltages." The result of a detailed study of the instantaneous currents, voltages and transformer flux density in the type of circuit involved were presented and from their study the following conclusions were arrived at:

The abnormal line-to-neutral voltages which have been observed at various times in the field and laboratory are the direct result of a succession of saturations taking place in the core of the transformer.

In the transient state the initial asymmetries of the core flux densities result in saturations of a highly irregular order and produce correspondingly irregular voltages having no definite frequency. The abnormal voltages are sometimes limited within a stable zone as a result of multiple saturations and thereby become sustained. The successive saturations giving rise to the abnormal voltages do not possess a definite frequency characteristic, and as a result frequencies occur which are not usually expected in ordinary alternating-current circuits. The minor and incidental characteristics of the published data bear a definite relation to the process of successive saturations and are adequately explained by this theory.

TWO OTHER papers, one by C. T. Weller, "Experiences With Grounded-Neutral Y-connected Transformers on Ungrounded Systems" and another "Physical Nature of Neutral Instability," by A. Boyajian and O. P. McCarty, also treated of high voltages from line to neutral and the shifting of the neutral in Y-connected transformers.

When a section of a system develops trouble it is desirable that this section be disconnected before the fault has had time to interfer with the rest of the system. Reactance-type distance relays have been developed for this purpose and have been in operation in this country for about a year. E. E. George in a paper, "Operating Experience With Reactance-Type Distance Relays," presented performance records taken during the 1930 lightning season of two types of these relays. One of these relays is a high-speed American built type, using a stepped time-distance characteristic. The other relay, using a sloped time-distance characteristic, is European built and designed for a more moderate speed of operation. These relays have performed satisfactorily on long transmission lines with wide variation in short-circuit conditions.

Operating experience has shown the correctness of the major principles of design and application of reactance-type distance relays on this system. Several difficulties have been encountered, but have been given less consideration than the prime object of carrying high load safely during emergency and of clearing the majority of faults selectively during all operating conditions.

THE ENGINEER'S BO

British Coal Industry

THE ECONOMICS OF THE COAL INDUSTRY. *By R. C. Smart. Published by P. S. King & Son, Ltd., 14 Great Smith St., Westminster, London, England; 1930. Cloth, 5½x9 in.; 268 pages, illustrations, charts and tables. Price, 12s.6d.*

"IT IS a curious characteristic of human mentality, especially noticeable in the British industrialist, that mankind is prone to think constructively only when trade is bad," says Mr. Smart in his most deprecatory manner. Judging by his description, the British coal industry must now be thinking hard, though it is questionable whether it is thinking any harder, or indeed needing to think any harder, than is the American coal industry.

A good feature of the British coal fields is their nearness to water transportation. "The average length of haul for export coal," says the author, "is 22 miles; for land sale, 49 miles, and for all freight traffic, 54 miles. . . . The Belgian coal fields are over 50 miles from the sea; French coal fields, 35 to 70 miles; German coal fields, 100 to 150 miles. . . . Polish coal is nearly 400 miles from the sea." It might be added, however, that the Ruhr coal of Germany is near the Rhine and therefore convenient to water transportation. On the other hand, no coal that is shipped for foreign trade in this country is located within 360 miles of the sea. Much of it would be farther except that distance hampers any extension of the area that might hope to export to foreign parts.

Because Great Britain has such ready access to the sea, the cost of coal delivered should be approximately the production cost. Any economies, therefore, affect almost the whole cost of the delivered article and not only the smaller part as in this country where the cost of delivered coal is usually, in the main, the freight charge and not the cost of production.

In 1928, according to Mr. Smart, only 25.4 per cent of the total salable output was cleaned, or 60 million tons. About 5,000,000 tons of removable dirt is burned under boilers in England, involving a transport cost of $12,500,000. As Germany washes 80 per cent of its coal and France 85 per cent, Great Britain, to use the vernacular, has got, as have we ourselves, a long distance to travel. However, the great natural purity of the British coals excuses, in a degree, the slowness of the operators to erect washeries, as is true also in the United States.

Mr. Smart's advice should, if duly heeded, do much to improve conditions. Mechanization, steady work at a reduced number of collieries, more loyalty of men to operators and operators to men, are the burden of the author's advice. With the advantage that every coal-producing county borders on the sea, these proposals should help to restore Great Britain's foreign trade and replace losses by profits.

Reviewed by R. DAWSON HALL.

The Keenan Steam Tables*

Reviewed by Dr. HARVEY N. DAVIS
President, Stevens Institute of Technology

STEAM TABLES AND MOLLIER DIAGRAM. *By Joseph H. Keenan. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York City; 1930. Cloth, 7½x10 in.; 63 pages of steam and conversion tables, one Mollier chart. Price, $2.*

TO THE MAN in the street a steam table might appear to be simply a needlessly extended arrangement of numbers chosen at random; to the rule-of-thumb engineer it is a more or less convenient source of quantities which, when substituted in formulas, give results that, so far as he knows, are all right; to the thoughtful engineer it is a compact summary of a vast amount of information useful in his business; to the research and development man it is interesting material that can simplify his work, or confuse it, according to the relative accuracy of his research and the table; to an author of a steam table it is an object of reverence and affection, if it is his own, or of searching and none too tolerant criticism, if it is someone's else.

I speak primarily as a thoughtful engineer, a research man, and an author. I have the opinion of the man in the street on good authority; the rule-of-thumb engineer I have frequently observed in offices as well as in college class rooms.

A steam table might commend itself to the experimentalist for the faithfulness with which it represents, interpolates and extends the best available experimental information; it might commend itself to the mathematician for its elegance of mathematical development; to the analyst for rigid thermodynamic consistency; to the pragmatist for ease and convenience in use.

Professor Callendar's earlier tables were loyally adhered to by many physicists and engineers in England and on the Continent for many years after experimental advance had shown them to be quite inaccurate even in ranges in which they were often used. Their reason for existence in the face of numerically more exact tables was, apparently, the elegance of the mathematical formulation on which they were based, and their resulting rigid thermodynamic consistency. Undoubtedly thermodynamic consistency, guaranteed by a formulation, is a great comfort to the physicist and research engineer provided accuracy is not too flagrantly violated. But as experimental knowledge increases, the probability of finding an equation of state for steam that is accurate, consistent and convenient seems to grow less and less. The modern framer of steam tables is therefore faced with the necessity of securing thermodynamic consistency by other means than a formulation, if he wishes the full measure of such accuracy as modern experimental data justify.

Professor Keenan has frankly abandoned the equation-of-state method of attack and has used a graphic method. The advantage of his method is its extreme flexibility. He is able to meet all the requirements of any working substance, regardless of its idiosyncrasies, vagaries or stubborness. The accuracy of the result is dependent only on the status of our experimental knowledge. On the other hand, the equation-of-state method to be practicable, must restrict itself to a certain range of characteristics, and each new bit of experimental information on steam seems to express its contempt for even the most complex equations of state. Carbon dioxide, methane, heptaine and many other substances have succumbed to the wiles of one or another equation, but steam is haughty and indifferent. Supreme in her H_2Oness, she has rejected all mathematical suitors and remains as yet unconquered.

The Keenan computation process adhered closely to experimental evidence. There was behind it over most of the range no hypothetical assumption based on the kinetic theory of gases (only the low-pressure end was slightly influenced by the usual kinetic theory of rarefied gases). There was no elegant mathematical development which it attempted to justify. It was simply a painstaking graphic development from the best experimental data extant by methods well founded in thermodynamics. Happily, no violence was done to any of the major bodies of experimental data in existence at the time of the development, and its agreement with such experiments as have

*Publication of the new Keenan tables by the A.S.M.E. early this year was a major event in power circles. The present brilliant review puts in a rather late appearance, but carries the name and keen analytical thinking of America's most penetrating commentator on steam research and steam-table formulation. *Power* feels that it was worth waiting for.—EDITOR.

S BOOKSHELF

been reported since its crystallization is most gratifying.

It is interesting to note that the table for superheated steam is arranged against temperature instead of superheat. This, doubtless, reflects a changing attitude in power production engineering. When the power plant was first weaned from saturated steam it was quite natural that designers and operators should think in terms of the excess of temperature over the saturation value. But the wide range of present-day operating pressures and the universality of superheat has reduced the significance of this excess. On the other hand, the rise of temperatures to the limits set by metallurgical development has served to emphasize temperatures as such. This is not, of course, the first steam-table tabulated against temperatures; Callendar, Goodenough and others had done it long before; but it is, I believe, unique in having lines of constant pressure and columns of constant temperature. The compactness of this arrangement facilitates interpolation.

For ease of manipulation it is important that a tabulation contain as small intervals and as few different quantities as possible. Keenan has kept the temperature intervals small by using a page with more columns than has been usual. He has retained quite moderate pressure intervals even at very high pressures. The table has been materially shortened and simplified by judicious omissions. For example, no internal energies appear in the saturation tables and no superheats are given in the table of superheated vapor. While these quantities might occasionally be found convenient if included, the advantage of having them explicitly stated is more than offset by a reduction in the number of lines and figures that must be leaped over and plunged into in selecting quantities or in interpolation.

This simplification shows up to good advantage in the tables for saturated steam. Besides the usual pressure and temperature columns there are three groups of columns, one each for specific volume, total heat and entropy. Each group consists of a column for saturated liquid, a column for change during evaporation and one for saturated vapor. This simple and symmetrical arrangement in itself concisely defines the quantities tabulated.

Symmetry of this sort in the volume group comes quite naturally with the advance in steam pressure. In the days of low-pressure operation the specific volume of the liquid was, so far as the engineer was concerned, minute and immutable—hence it was not tabulated. But all this has changed. The present-day steam table treats specific volumes just as it does total heats and entropies, and it recognizes that the change of volume during vaporization is not identical with the volume of the saturated vapor.

This point suggests another departure which must come with the next steam-table development. The present table for superheated steam stops at the left side of the page in a stepped line which marks the saturation limit. To the left of this line lies the compressed liquid which has specific volume, total heat and entropy just as does superheated steam. In the days of low-pressure operation we did not ask that this region be considered by the table makers, because certain simple assumptions, such as constant volume during compression, constant internal energy at constant temperature, etc., took the place of a tabulation of properties. But now that pressures above 1,000 lb. per square inch are becoming commonplace, these assumptions are not only old fashioned, they are inadequate.

Our need for a tabulation of the compressed liquid is so evident that one might ask why Professor Keenan did not include one in his book. As a matter of fact he has a very good excuse, namely, that he did not know anything about the compressed liquid. Nor did anyone else until several months after the date of publication. Dr. Keyes and Dr. Smith at M.I.T. have very recently made available a series of specific volume measurements in this region which, with very little additional information, will make it possible for the steam table of the future to extend without a gap from 32 deg. F. to the upper temperature limit at all pressures.

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Coal Data

TRANSACTIONS, COAL DIVISION, A.I.M.&M.E. *Published by the American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City; 1930. Cloth, 6x9 in.; 724 pages, illustrations, charts and tables. Price, $5.*

THIS is the first volume to be issued by the Coal Division of the Institute and contains the principal papers and discussions on coal that have been presented during the last three years. Among the subjects that are of special interest to power engineers are four papers on the cleaning of coal and a group of excellent papers on coal classification that cover over 300 pages of text and tables. The treatment is exhaustive and provides a splendid reference for the combustion engineer.

Cost Analysis

PRINCIPLES OF ENGINEERING ECONOMY. *By Eugene L. Grant. Published by the Ronald Press Company, 15 East 26th St., New York City; 1930. Cloth, 6x8 in.; 387 pages. Price, $3.75.*

ENGINEERS are continually confronted with problems that involve considerations and comparisons of cost. Arthur Wellington's remark that engineering was the art of doing well for one dollar what any bungler could do for two dollars, places striking emphasis on the point.

This book has been prepared to serve as a text for those who wish to study the principles of engineering economy. It has been divided into three parts. Methods of placing costs and revenues on a basis where they may be equally and conveniently compared with one another form the subject of Part I. Part II has fact finding as its subject and briefly considers technical tests, research activities, statistical and accounting records, and cost estimating. Part III discusses points of view, judgment factors and expression of results of economic studies.

Principles of cost comparison have been illustrated and explained by discussion of particular cases rather than in terms of mathematical formulas. Although the particular cases used are in general not related to power subjects, the principles illustrated are applicable to power plant economics.

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The Evolution of Number

NUMBER, THE LANGUAGE OF SCIENCE. *By Tobias Dantzig. Published by the Macmillan Company, 60 Fifth Ave., New York City; 1930. Cloth, 6x9 in.; 250 pages, illustrations, diagrams and tables. Price, $3.50.*

NUMBER, counting the simpler forms of mathemaitcs, are so much a part of our mental equipment today that few of us can conceive of a period in the history of man when they did not exist. Yet, there was such a time, and it took many thousands of years and a few "fortunate accidents" to produce the convenient and useful tool we now employ in virtually all of our activities.

The story of this interesting development is entertainingly told in the present volume by Dr. Dantzig, professor of mathematics at the University of Maryland. As he relates the evolution of the modern number concept from the finger counting of the caveman to the theories of Einstein, he not only explains most of the great mathematical discoveries since the earliest days of known civilization, but also emphasizes the cultural value of the mathematical sciences—a side of subject all too often overlooked in the rush and confusion of this practical age. He does not always follow historical sequence, for mathematical discoveries did not follow

one another in an orderly fashion. Strange as it may seem, many of the so-called "higher" mathematics were discovered first. This paradox is explained by the influence of the Greeks, who were concerned mainly with geometry.

The origin of the zero, the use of symbols, the notion of infinity, transcendentals, amicable numbers, perfect numbers, and the various theories of the last number are only a few of the many fascinating subjects explained in the course of Dr. Dantzig's book. Furthermore, it is embellished throughout with the type of background material that gives living significance to the science of mathematics. It cannot be recommended too highly.

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Power Plant Economics

GENERATING STATIONS. *By Alfred H. Lovell. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Cloth, 6x9 in.; 359 pages, 171 illustrations, 24 tables. Price, $4.*

ECONOMICS is finding an ever-increasing importance in engineering and in this book the author has set forth the economic elements of electrical design. There is presented the application of economic principles to the broad engineering problems of electric generating stations and transmission line design, in selecting apparatus, proportioning details in an assembly, and in balancing initial and subsequent cost.

As indicated by the chapter headings, the first part of the book deals largely with the economic phases of power system design, those factors that must be given a proper weight if the best use is to be made of the money invested in the undertaking. Such subjects as depreciation, obsolescence, plant costs and proper balance between fixed and operating costs have been given extensive treatment including methods of attacking these problems.

Before a power plant can be constructed the characteristics of the load to be served must be known and a design laid down that will meet both present needs and the requirements for a reasonable time in the future. To this end considerable space has been given in the study and analysis of load curves. When the plant has been designed for a given set of conditions, equipment must be selected to control and protect the electrical equipment, and it is to this purpose that the last four chapters are devoted.

Throughout the work the economic selection of equipment for specific conditions has been emphasized, always with the object in mind to produce power as cheaply as possible, taking into account the quality of the service to be rendered. The book is intended for use by college students and engineers interested in plant design and to these it offers much valuable information.

Oil Power Handbook

DIESEL POWER PLANT HANDBOOK. *By Julius Kuttner. Published by Diesel Power, 521 Fifth Ave., New York City; 1930. Cloth, 7½x10½ in.; 130 pages, 127 illustrations. Price, $4.*

A VOLUME of this type is issued by *Diesel Power* each year, being, in principle, a yearbook with the usual advertising pages. The operator of an oil engine will find considerable information of value in the several chapters, although it is unfortunate that Ludwig Hausfelder was not credited as the source for much of the data on oil engine developments. As examination of patent records is laborious, this searcher deserves full credit for his discoveries.

With some of the author's statements, such as "every foot-pound of work during compression is returned during the expansion stroke," one finds agreement difficult, unless the ideal engine be under examination. In his statements of thermodynamic laws, the author is not precise. The second law of thermodynamics is *not* based, as he says it is, on the fact that heat will not flow from a body of lower temperature to one of higher temperature. The very necessary qualification that this is true when no external energy is added should not have been ignored. Technical readers will, of course, insert this clause, but the average reader may be led astray. There is, in addition, a tendency, so prevalent among some writers, to replace the usual symbols in well-known formulas, by others, so that the reader is often deceived as to the interpretation.

In spite of such deficiencies, which after all are minor, the volume is an excellent addition to oil engine literature.

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Metal and Chemical Data

METALLURGISTS AND CHEMISTS HANDBOOK. *Compiled by Donald M. Liddell. Third edition, revised and enlarged. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Flexible leatherette, 4½x7 in.; 847 pages. Price, $5.*

THIS THIRD EDITION brings Liddell's handbook up to date and adds about 30 per cent to its contents. Yet, thanks to the use of thin paper, the volume slips conveniently into the pocket. While this handbook is designed especially for metallurgists and chemists, and contains certain specialized material of interest to them only, it also offers much of value to the power engineer. In particular, if the work of the power engineer involves research or scientific studies in the solution of unusual operating problems, he will find in this handbook information on the chemical and physical properties of materials, alloys, etc., not given in his ordinary mechanical handbooks.

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Brief Reviews

TRANSACTIONS VOL. VIII, 1927-28, OF THE NEWCOMEN SOCIETY. Copies may be secured through C. E. Davies, corresponding secretary, 29 West 39th St., New York City. Paper, 194 pages, illustrated; price, 20 shillings.—Interesting data on early steam navigation on the ocean and Lake Champlain, besides much other historical information.

METHODS OF TEST RELATING TO ELECTRICAL INSULATING MATERIALS. Report of Committee D-9 on Electrical Insulating Materials of the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. Paper, 192 pages; illustrated; price, $1.25.—A handy reference publication for those interested in the most recent methods of testing insulating materials.

MECHANICAL CATALOG, 1930-31. Twentieth annual volume published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. Flexible leatherette; 1,104 pages, illustrated.—A conveniently classified directory describing the products of manufacturers of mechanical and industrial equipment and materials.

THE UNITED KINGDOM. By Hugh Butler. Published by the Bureau of Foreign and Domestic Commerce, Washington, D. C. Cloth; 953 pages, illustrations, maps, charts and tables; price, $1.75.—An industrial, commercial and financial handbook prepared by the American Trade Commissioner in London in co-operation with officials of the Departments of Commerce and State.

MODERN CENTRAL STATIONS. Volume Six of a series published by the Ingersoll-Rand Company, 11 Broadway, New York City. Paper; illustrations, charts and tables; free.—A collection of reprints of articles describing Pasadena, Riverbend, Ohio River, James H. Reed, San Francisco, Deepwater, South Amboy, Mobile, New Gorgas, El Paso and Devils River central stations. Two other articles are also included—"Central Stations," by George A. Orrok, and "Recent Research on the Thermal Properties of Steam," by Harvey N. Davis and Joseph H. Keenan.

BEAUHARNOIS. Published by the Beauharnois Power Corporation, Ltd., University Tower, Montreal, Canada. Paper; 27 pages, illustrations, charts and tables; free.—An interesting description, fully illustrated, of the mammoth hydro-electric project at Beauharnois, Quebec.

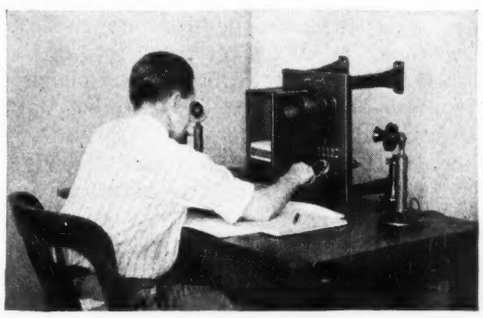
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Controlling Remote Electric Equipment by Audio-Frequency Impulses

A NEW TYPE of equipment for controlling the operation of remote automatic electric devices by audio-frequency impulses has been introduced by the General Electric Company, Schenectady, N. Y.

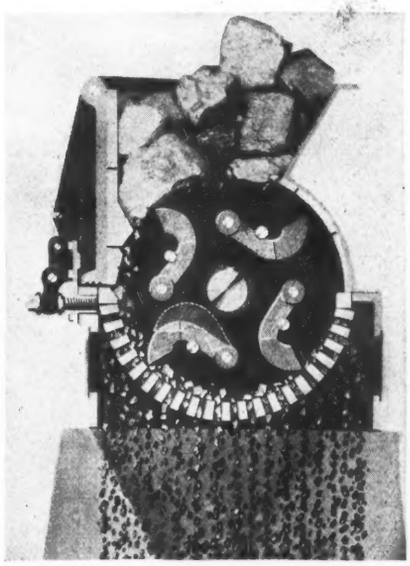
The new control, known as the audible-selector type supervisory equipment, is applicable to the operation of various types of electric machinery. Automatic hydro-electric generating plants in central station systems, automatic pumping stations, etc., may be controlled from a remote point.



Dispatcher's control panel showing dial, howler, etc. and control panel for the remotely controlled station

The supervising equipment, located in the dispatcher's office, consists of a wall panel on which are mounted a calling dial similar to those used on dial telephones, a reset key, a howler and an audio-frequency transmitter. The supervisory equipment, located in the outlying station to be controlled, consists of selector switches, auxiliary relays, etc., necessary to adapt the supervisory system to the control circuits of the devices supervised.

When the dispatcher desires to operate a unit in an outlying station he dials the proper code to select that unit. A series of audio-frequency impulses are transmitted over the line wires to the selector switches in the outlying station. The selector switches take a position corresponding to the numbers dialed and start a code-sending device which checks the position of the selectors by sending a return code to the howler in the dispatcher's office. The howler has two tones, high and low pitched, the one indicating that the unit is running and the other that the unit is stopped. The dispatcher, knowing the selector switches are set on the position corresponding to the unit he wishes to operate and knowing whether the unit is in the open or closed condition, can then dial a signal to start or stop the unit. He immediately receives a signal via the howler to indicate that the desired operation has taken place.



Cutaway view of Flextooth crusher

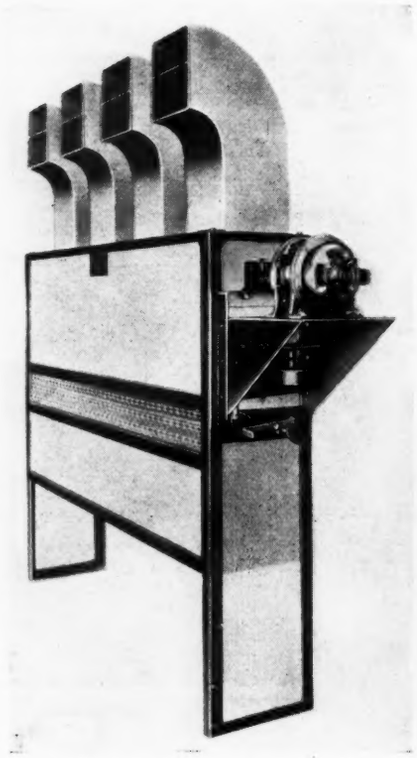
New Design Single-Roll Coal Crusher

DESIGNED to produce smaller uniform sizes of coal than are readily obtained with the standard roll crusher, the "Flextooth" crusher put out by the Jeffrey Manufacturing Company, Columbus, Ohio, is available in seven sizes ranging from 20x12 to 42x48 inches.

As will be apparent from the illustration, the crushing element consists of a roll equipped with hinged teeth. In operation, the teeth are kept in the outward position by centrifugal force, but are free to swing-back below the surface of the roll should foreign matter be encountered. A hinged breaker plate allows ready access to all working parts, and a large screening area gives large capacity of uniform product. Capacities of the smaller size mentioned above are given as 25 tons per hour of 2-in. product and 5 tons of $\frac{1}{4}$-in. product; in the larger size 350 tons of 2-in. and 90 tons of $\frac{1}{4}$-in. product are obtainable. Sizes between these two have corresponding capacities.

Unit Heater Designed for Manual and Automatic Control

UNUSUAL control features are embodied in the new "Super Control" heat-diffusing unit put out by the York Heating & Ventilating Company, Philadelphia.



Unit heater designed to give low final air temperature

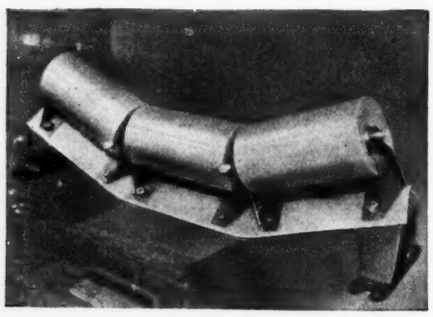
The principle of operation is that the necessary heat output of the unit shall be mixed with room-temperature air within the heater so that the resulting mixture is always held at the lowest possible final temperature consistent with producing the required room temperature. It is pointed out by the manufacturers that an air stream carrying the necessary heat content is more easily held in the lower areas when the temperature of the mixture is maintained at the lowest possible temperature, and that by tempering the heated air within the heater it is possible to reduce to a minimum the tendency of the air stream to rise.

The same principle of high-velocity discharge as used in former models has been retained. This high velocity results in a long horizontal movement of the leaving air and permits it to spread more evenly.

Mixing of the heated air and room-temperature air within the heater is effected by two automatically controlled dampers, one of which regulates the amount of air passed over the steam heating element and the other the amount of air entering through the inlet in the front above the heating element. Control for these dampers is mounted on the end directly below the fan motor.

In addition to the full automatic control for regular operation, an aqua switch may be applied to the return line. This switch, operating in conjunction with an automatic starter, functions to stop the motor when the steam supply fails or is shut off.

No throttling of the steam is required, the unit being designed to operate with full steam pressure on the coils at all times. Units can be furnished for either manual or automatic control.



Improved Belt Conveyor Carrier

IN THE new roller bearing belt conveyor carrier, designated "Pacific," put out by the Stephens-Adamson Manufacturing Company, Aurora, Ill., each roller with its bearing is a self contained unit and can be interchanged with any other roller without disturbing the bearing adjustment.

Each roller is equipped with two tapered roller bearings especially housed and protected from dust and moisture by an intermeshing labyrinth grease seal. The bearings are large in size and are arranged to carry both end-thrust and radial loads. The inner hub extends the full length of each roller and prevents misalignment of bearings.

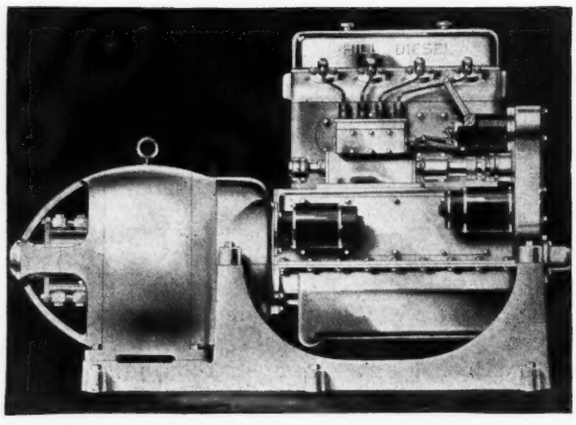
The cross member is a single structural steel angle that is self-cleaning and eliminates any tendency for material to collect beneath the rollers.

The carrier is built in sizes from 18 to 48 in. wide.

Diesel Engine-Driven Generating Units in Small Ratings

FURNISHED in 10-, 15- and 20-kw. sizes, the small diesel generating set illustrated, put out by the Hill Diesel Engine Company, Lansing, Mich., is particularly suitable for emergency lighting, excitation and other auxiliary service.

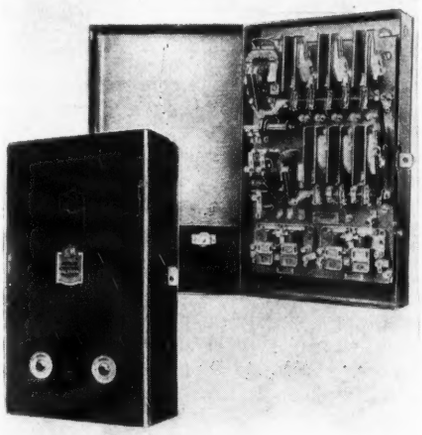
It is a four-cylinder, four-stroke-cycle unit designed for speeds up to 2,000 r.p.m. and a rating of 40 hp. The bore and stroke are $3\frac{1}{2}$ and 6 in., respectively. The same fuel system as used on the larger Hill diesels is employed on the new unit. A governor controls the fuel admission and holds the speed within close limits. Fuel consumption at rated load is given as 0.44 lb. per horsepower-hour. Injection pumps, one for each cylinder, are combined into one unit, as also are the water and oil pump. A filter is provided on both fuel and lubricating oil, and the unit is completely equipped with charging generator and electric starter. Specifications of the 20-kw. size, which is illustrated, are: speed, 1,750 r.p.m.; weight, 1,600 lb.; length, 63 in.; width, $28\frac{1}{2}$ in.; and height, 42 inches.



Four-cylinder four-stroke-cycle diesel unit

New Automatic Controller for A.-C. Motors

CUTLER-HAMMER, INC., 190 12th St., Milwaukee, Wis., has brought out an automatic controller for two-speed, consequent-pole, squirrel-cage motors. Designated Bulletin 9739, it functions to start the motor and to change its speed by reconnecting the motor windings. It provides thermal overload protection at both motor speeds and low-voltage protection. A separate push-button master switch with "stop,"



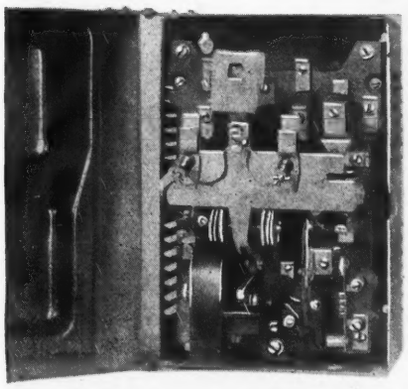
Automatic controller for two-speed, constant-pole, squirrel-cage motors

"low" and "high" buttons provides three-wire remote control.

The new controllers are furnished for constant horsepower, constant-torque or variable-torque motors. A sequence-compelling feature can be supplied that makes it always necessary to start the motor on low speed before bringing it up to high speed. The entire mechanism is mounted on a single slate panel, and the split-type inclosing case provides easy access to all parts when the cover is opened.

Complete Line of Timestarters

A COMPLETE line of remote-controlled, magnetic starters for constant- and adjustable-speed direct-current motors in sizes up to 10 hp., 230 volts has been made available by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. They provide three points of definite time limit acceleration. Four combinations are included in the line. Class 8512-A, for constant-speed motors, does not provide overload



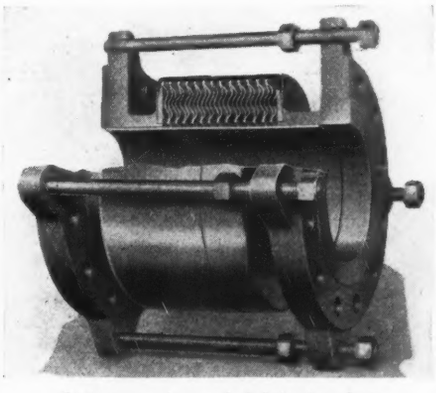
Timestarter provides overload protection, dynamic braking and full field starting

protection or dynamic braking. Class 8512-B, for constant-speed motors, provides thermal relay overload protection but not dynamic braking. Class 8512-C, for constant-speed motors, provides overload protection and dynamic braking. Class 8512-F, for adjustable-speed motors, provides overload protection, dynamic braking and full field starting.

The different combinations are made possible by the addition of certain parts to a standard chassis, consisting of a three-point accelerating contactor. Bobbin-type resistors mounted on the rear of this unit provide the necessary resistance between points of acceleration. Inverse-time-limit overload protection is by the overload relay, arranged for either hand or automatic reset. Either low-voltage protection or low-voltage release may be obtained, depending on the type of master switch used. The new timestarters can be operated by practically all types of auxiliary control switches.

Improved Expansion Joints

IN THE improved type of expansion joint designated "Flexo Disc" recently introduced by the



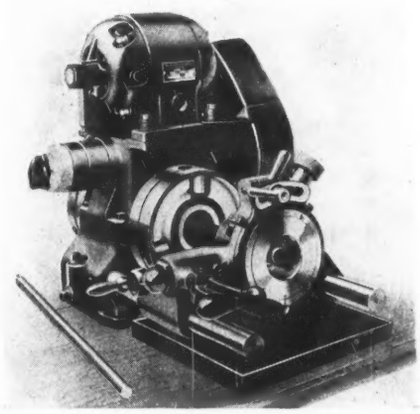
Cutaway view of joint showing design of expansion element

Croll-Reynolds Engineering Company, Inc., 17 John St., New York City, the expansion element is a completely welded assembly of corrugated steel disks. After welding, which is done by the atomic-hydrogen process, the complete element is heat-treated to obtain uniform quality and relieve local stresses set up by the welding. The element is welded at each end to cast-steel flanged heads that are guided relative to each other to permit of longitudinal movement only. To protect the element against foreign matter a sleeve with a sliding fit is provided both inside and outside, as shown.

Joints of this type, with either flanged or welded ends, are now available for working pressures up to 30, 125 and 250 lb. A special design is used where lateral or angular misalignment must be provided for, and for service on lines handling corrosive liquids, gases or vapors.

Small Size Pipe Machine

WHAT IS SAID to be the smallest, complete pipe machine available, designated Tom Thumb, has been announced by the Oster Manufacturing Company and the Willams Tool Corporation of Cleveland, Ohio. Although the machine will cut off, thread, ream and chamfer all sizes of pipe from $\frac{1}{4}$ to $1\frac{1}{4}$ in., its over-all di-



Machine threads pipe from $\frac{1}{4}$ to $1\frac{1}{4}$ in. and bolts from $\frac{3}{8}$ to $1\frac{1}{2}$ in. in diameter

mensions are only $18\frac{1}{2}$ in. in height, 16 in. in width and $23\frac{1}{2}$ in. in depth. It is driven through a V-belt by a $\frac{1}{2}$-hp. universal motor that automatically adjusts its speed to the pull of the dies. Anti-friction bearings are used throughout. A special bolt chuck has been designed for use with the machine that makes it possible to thread bolts from $\frac{3}{8}$ to $1\frac{1}{2}$ in.

NEWS of the FIELD

Spot News

ESTABLISHMENT *by the Department of Labor of a Public Employment Service at Las Vegas, Nev., to handle employment on the construction of Hoover Dam, was announced Nov. 24 by Secretary of the Interior Wilbur. This office will not only direct men to employment, but will supply the country with information concerning the progress of work on the Boulder Canyon project and the demand for workmen.*

INSTALLATION *of three synchronous condensers, totaling 20,000 kva., in plants of the Buick Motor Car Company at Flint, Mich., will mark the largest power-factor improvement undertaking ever made by an industrial plant. The order for these machines, consisting of one 10,000-kva., one 6,000-kva. and one 4,000-kva. condenser, was recently placed with the Electric Machinery Manufacturing Company of Minneapolis.*

THE NEW *Ruskin hydro-electric plant of the British Columbia Electric Railway Company, on the Stave River, was officially opened on Nov. 18. Constructed at a cost of $7,226,000, the development adds 47,000 hp. to the power supply available to Vancouver and adjacent cities, bringing the total supply to 202,000 horsepower.*

ANNOUNCEMENT *was made on Nov. 24 that the International Paper & Power Company will soon commence the installation of another 34,000-hp. generator in the Paugan, Que., hydro-electric plant of its Gatineau Power Company. Already one of the greatest water-power plants in North America, Paugan will have an installed capacity of 238,000 hp. upon completion of the new unit.*

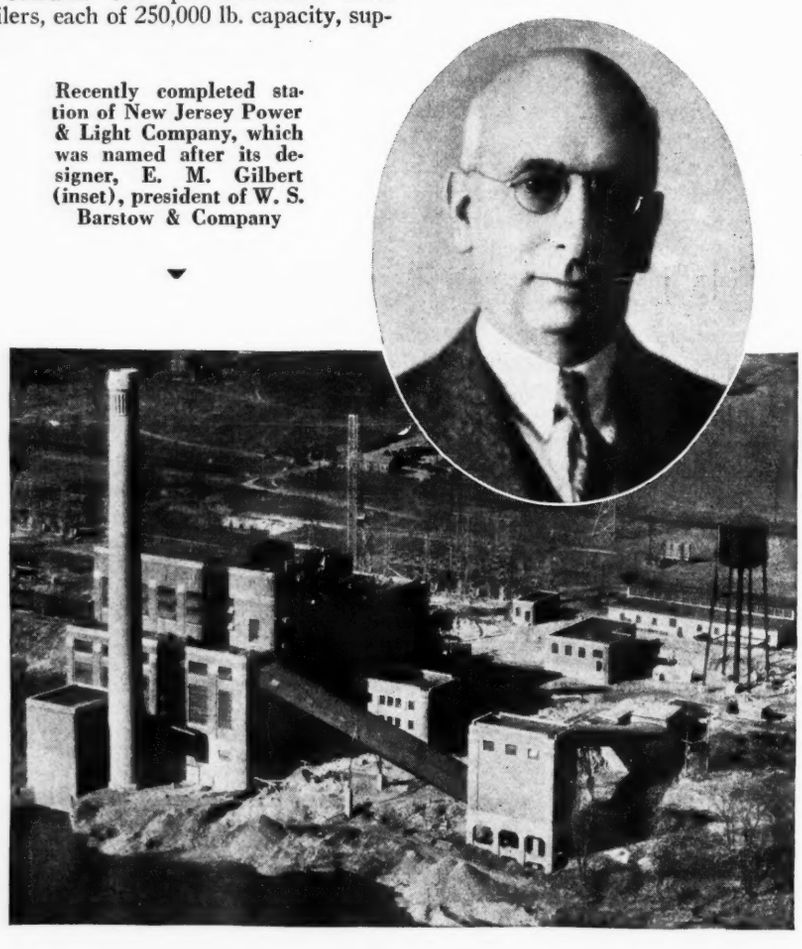
Gilbert Generating Station Dedicated At Holland, N. J., With 500 Present

New 1,200-lb. plant named in honor of its designer. Record performance of 11,866 B.t.u. per kilowatt-hour attained

NEARLY 500 prominent engineers and financiers from many sections of the country were the guests of the New Jersey Power & Light Company on Nov. 20 at the dedication of its new station at Holland, N. J., named in honor of E. M. Gilbert, president of W. S. Barstow & Company, who was responsible for the design.

This plant, formerly known as the Holland station, is one of first complete 1,200-lb. installations and has been in operation since last March. At present it contains two pulverized-coal fired boilers, each of 250,000 lb. capacity, supplying steam at 1,200 lb. to a 12,000-kw. high-pressure turbine which exhausts at around 400 lb. to a 43,000-kw. low-pressure unit, making the present capacity 55,000 kw. Refinements in design include economizers and air preheaters, both gas and steam reheaters and evaporators employing pretreated water. The wall between the boiler room and turbine room has been omitted, and all equipment, with the exception of the coal-handling and milling machinery, is controlled automatically or may be handled through push-buttons by the station operator from a central point.

During the few months that the station has been in operation exceptional



Recently completed station of New Jersey Power & Light Company, which was named after its designer, E. M. Gilbert (inset), president of W. S. Barstow & Company

performance has been attained, reaching for one week the record figure of a net kilowatt-hour on 11,866 B.t.u., which corresponds to a thermal efficiency of 28.75 per cent. Several other weeks showed less than 12,500 B.t.u. per kilowatt-hour.

Preceding the dedication of the station a banquet was held at the Hotel Easton, at Easton, Pa., with C. S. Banghart, vice-president and general manager of the Pennsylvania-New Jersey Division of the Associated Gas & Electric Company, presiding. Speeches were made by the mayors of Phillipsburg and Easton and by Mr. Gilbert. After the banquet a special train conveyed the guests to the plant for inspection and the dedication.

Water Suit May Delay Work on Herndon Steam Plant

Construction of the 50,000-kw. steam plant which the San Joaquin Light & Power Corporation plans to build at Herndon, Calif., on the San Joaquin River, about ten miles north of Fresno, may be delayed or prevented if recently instituted litigation involving riparian rights on the power plant site is decided in favor of the plaintiffs. The suit was brought by the San Joaquin and Kings River Canal and Irrigation Company against the Lisenby Estate Company, from which the power company purchased the property, and was filed before the consummation of the purchase by the power company. The suit seeks to condemn water riparian to the Lisenby Estate Company's property on the San Joaquin River, of which the power plant site was a part, on the grounds that the water is necessary for irrigation purposes.

If the suit is decided in favor of the plaintiffs and the water diverted from the plant site, the power company would be deprived of its use for cooling purposes. This use of the water would not decrease the flow of the river, according to company officials, because the water, being used for cooling only, would be returned to the river.

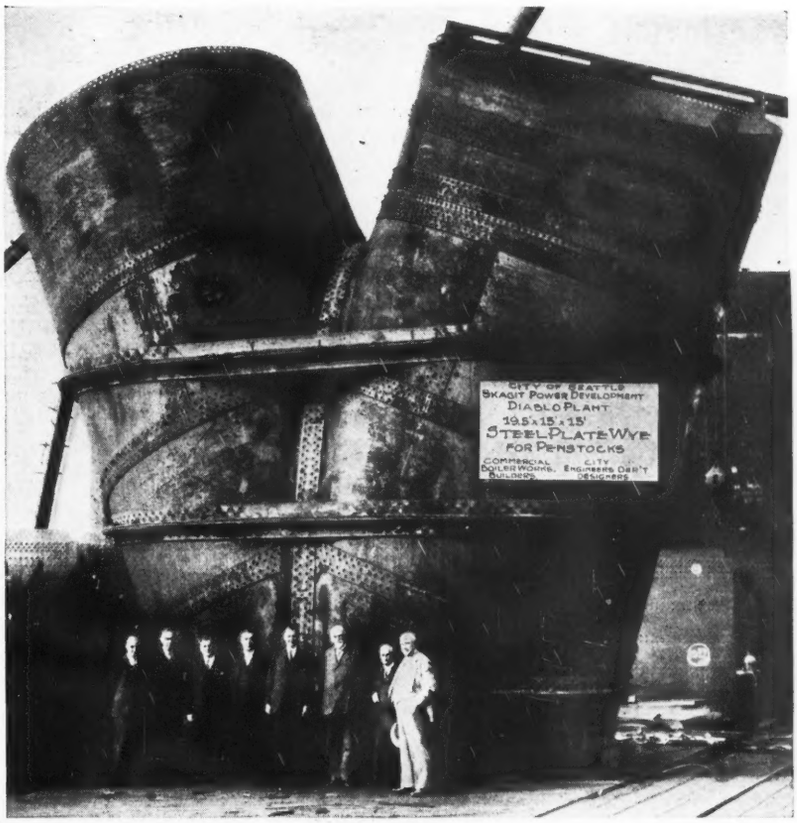
The power company is going ahead with its plans, and it is believed that a compromise will be effected.

Farmer Dynamites Dam; Is Sued for Damages

Following the dynamiting of a 40-ft. section of a small wooden dam at Hat Creek on the Pacific Gas & Electric Company's Pit River system on Nov. 10 by Louis P. Joerger, a disgruntled farmer in a dispute over riparian rights, the company on Nov. 19 filed a $9,367 damage suit against Mr. Joerger, and asked for a restraining order and an injunction forbidding him to molest the dam further. The restraining order has been issued and the defendant cited to appear in court Nov. 26 and show cause why a permanent injunction should not be issued. Shortly after the dynamiting the damage had been repaired and the power house was functioning as usual. Mr. Joerger had freely admitted the dynamiting and had announced that he would wreck the dam again if repairs were made by the company.

The dispute between Mr. Joerger and the power company is one of a number of years' standing and revolves about claims for water riparian to the farmer's holdings and damages to his property as a result of the power company's development. A partial judgment of $40,000 was awarded Mr. Joerger some time ago for some of the rights he claims, and suit is still pending on his other claims.

LARGEST STEEL-PLATE WYE



THE LARGEST STEEL-PLATE WYE in the United States and probably in the world, according to engineers, has just been delivered to Seattle's Diablo power dam, a unit of the city's hydro-electric project on the Skagit River in northern Washington. This immense penstock is constructed of ¾-in. steel, 65 tons of plates being used in this section of the penstock. It is reinforced by three steel bands, 21, 25 and 30 ft. in length, respectively. The diameter of the main section is 19.5 ft. while each of the smaller sections measures 15 ft. in diameter. The wye was fabricated by the Commercial Boiler Works, Seattle, and shipped to Diablo in sections for assembly. It was designed by the city's engineering staff, some of which are shown in the illustration.

From the reservoir back of the dam, water will be brought through a 2,000-ft. tunnel, 19½ ft. in diameter. At the mouth of the tunnel it will enter the steel penstock which will be embedded in reinforced concrete. Through the immense pipes two streams of water, each 15 ft. in diameter, will drop 189 ft. to the power house where each stream will drive a generator of 95,000 hp. From dam to waterwheels the water will have a head of 325 ft. The height of the section is 33 ft. while the breadth at the broadest portion is 30 feet.

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To Study Operation of Los Angeles Power Dept.

A survey of the operation of the Los Angeles Water and Power Department by impartial experts employed by the Board of Water and Power Commissioners has been agreed upon by members of the board and committees of the city council. The action was authorized at a conference Nov. 20.

Outside technical experts will be engaged immediately by the board, and they will make such recommendations as they deem necessary and will advise the city council. It was pointed out that the investigation is to be one of methods and not of personnel.

Interesting Papers Feature Meeting of Practical Refrigerating Engineers

IN SPITE OF the general business depression, the National Association of Practical Refrigerating Engineers convention held at Memphis, Tenn., from Nov. 11 to 14, was attended by over 300 delegates, who were privileged to listen to the best program of engineering papers the association has ever prepared. After the customary registration, addresses of welcome and presidential address, which were included in the opening session, the convention turned to the presentation of the papers.

"Analyzing Power Contracts" was the subject covered by the paper of R. H. Smith, Westerlin & Campbell Company. The author went into the matter at some length, showing the engineers how various rate structures were erected, and the method of analyzing the several items of demand, connected load and energy charges, to arrive at the actual power cost per ton of ice. The disadvantage of a high demand charge, even when accompanied by a low energy rate, was pointed out, and the proper method of handling the plant to obtain the lowest possible demand was explained. This paper will be published in a later issue of *Power*, as also will be the paper by E. T. Quinn, on "Practical Methods of Varying the Capacity of Ice Plants to Meet Load Conditions." The latter was awarded a prize of $200 as being the best paper presented. It is of interest that Mr. Quinn is not an engineer but in the business department of a refrigerating plant. The paper covered all the various methods of speed control, volume control, and balancing of machine loads.

"Rebuilding Ice Manufacturing Plants to Obtain Lower Operating Costs," by H. T. Holbrook, was a concise discussion of the proper method of ascertaining the net saving obtainable by the installation of a new machine. The author pointed out that no engineer can hope to convert the management to the purchase of new equipment if he is not able to submit, along with his recommendation, a complete and detailed analysis of the present total costs with the present obsolete unit and with the contemplated new machine. Rebuilding, so the author stated, is different from new construction, since new machines must be installed in existing buildings, that may upset the layout.

The convention was especially interested in a paper on "Sleeve-Valve Compressors," by E. Prestage of Liverpool, England, designer of a machine of this type much used in England. The speaker explained that in England slow-speed compressors are no longer popular and to meet the demand for high-speed units the sleeve-valve compressor was introduced. In this machine the sleeve uncovers the suction and discharge ports, quite in the same fashion as the sleeve does in a gasoline engine. Clearance can be small, and as the sleeve moves but one-half inch there is no high valve inertia as with poppet valves. Speeds of 1,000 r.p.m. are obtainable with ease, according to the speaker. The compressor is being tested out by an American compressor manufacturer, with a view to its manufacture.

The paper "Diesel Engines for Refrigerating Plants," by O. Nonnenbruck and C. R. Neeson, was an outline of the various ways of driving a compressor by an oil engine. The authors were favorable to direct-connected units but conceded that there are times when a belted unit is best to meet existing conditions of compressor speeds or floor space. The necessity of non-scale-forming cooling water was stressed, as was also that of vibration-free foundations.

Since quick freezing is bringing new problems to the engineer, close attention was given the paper by Prof. W. R. Woolrich, University of Tennessee, on "Physical and Chemical Properties of Food Stuffs." This paper will be published later, as it contains tables of considerable importance.

G. Fred Sherman, in a paper on "The Welded Joint in the Refrigerating Plant," went into the details of how to detect the quality of a welded joint, which must be both tight and strong. It was the author's claim that it is as easy to obtain a welded joint as a screw joint, and a test weld will always indicate a welder's ability. He also favors the tube turn in preference to radius bends and cited tests by Professor Pond of Rice Institute to uphold his claims.

The final paper, by Prof. E. L. Carpenter, University of Tennessee, on "Industrial Management," was a brief résumé of the development of the factory system.

The final session was devoted to the election of the officers for ensuing years. The following were the chosen leaders: President, W. C. Reinhard, Houston, Texas; 1st vice-president, James S. Spalding, Memphis, Tenn.; 2nd vice-president, John W. Neff, La Grange, Ill.; secretary, E. H. Fox, Chicago, Ill.; treasurer, J. E. Petermann, Hubbard Woods, Ill.

As is usual with the N.A.P.R.E., especial attention was given to the social side of the convention. Besides the yearly banquet, there was a smoker and a frolic, as well as numerous teas and theater parties for the women.

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PRESENTING THE MOREHEAD MEDAL

J. B. Johnson, receiving Morehead Medal at the recent convention of the International Acetylene Association. Left to right: C. A. McCune, retiring president of the association; J. B. Johnson; A. Cressy Morrison, secretary-treasurer; W. A. Slack, past-president who presented the medal; W. D. Flannery, president-elect. Mr. Johnson, who is chief of the material branch of the Army Air Service at Dayton, Ohio, was awarded the medal for original work in aircraft welding.

A.S.A. Approves Standard for Coal Analysis

The American Standards Association has approved American standard methods of laboratory sampling and analysis of coal and coke submitted by the American Society for Testing Materials, which is the proprietary sponsor for the project. These methods were originally prepared by joint committees of the A.S.T.M., American Chemical Society, and the American Foundrymen's Association. They were adopted by the A.S.T.M. in 1916 and 1918, and were revised in 1921, 1924, 1927, 1929, and 1930 by its committee on coal and coke.

The recent revisions of the methods

consist of minor changes in some of the methods of test and do not radically alter any of the procedures. These changes are the result of investigations of the methods of analysis with a view of increasing their accuracy. Many of the determinations made in analyzing nature and methods of this character coal and coke are in part empirical in require close standardization to secure good agreement between different laboratories.

The standards just adopted are generally recognized and used by most of the large consumers of coal in the United States. The methods are extensively used in purchasing coal under specifications for power production. They are also used by large coal producers who process their coal before marketing to improve its quality, and are in general use for evaluating coals for gas and coke plants. The methods of coke analysis are principally used for evaluating coke for metallurgical purposes.

Christy Heads New Hudson County Smoke Bureau

William G. Christy, mechanical engineer of the Board of Education of St. Louis, Mo., has been appointed engineer in charge of the newly organized Smoke Abatement Bureau of Hudson County, N. J. The bureau will be a new department of the Hudson County Board of Health.

The campaign of the new bureau will be conducted in co-operation with Stevens Institute of Technology at Hoboken, where Col. Elliott H. Whitlock, former smoke commissioner of Cleveland, Ohio, is in charge of smoke abatement research. Colonel Whitlock will co-ordinate all smoke activities in various counties and municipalities of New York, New Jersey and Connecticut with the smoke abatement campaign in New York City. Hudson County is appropriating $40,000 for the first year's work. Mr. Christy will have full charge of the campaign, the budget for 1931 providing also for a deputy engineer and six smoke inspectors. This is the first time in this country that a county has set up a smoke department.

As chairman in 1926 of the St. Louis Section of the American Society of Mechanical Engineers, Mr. Christy was active in the organization of the Citizens Smoke Abatement League of St. Louis and was responsible for bringing to St. Louis Dr. O. P. Hood, chief technologist of the United States Bureau of Mines, who formulated the plan under which the league operated. For two years Mr. Christy was executive secretary of the Smoke Abatement League, having charge of the most comprehensive smoke campaign in the United States. He was also active in the organization of the campaign to raise $250,000 by popular subscription to carry out a three-year smoke abatement program in St. Louis.

Federal Power Commission Annual Report Shows Many Large Projects Under Way

CONTROL over water-power developments is declared to be primarily a responsibility of the individual states in the annual report of the Federal Power Commission made public Nov. 28 by Ray Lyman Wilbur, Secretary of the Interior and acting chairman of the commission. The report cites complaints made by state authorities that the government in some instances has been inclined to encroach upon the rightful field of state activity to such extent that confusing duplication of authority occurs. In this connection the report points out that "clearly the government has the principal obligation in safeguarding the interests of navigation and the federal properties as may be affected by water-power projects, but in other respects the control of these developments is largely a matter of state interest. Since this situation involves a considerable degree of dual authority, there are present the elements of possible conflict and confusion which might seriously impede desirable developments unless the state and federal agencies find a basis whereby each may properly supplement and not duplicate the other."

The report reveals that the activities of the commission to date have mainly concerned the Western states since very few of the 449 projects licensed so far are east of the Mississippi River. According to the report "they are scattered through many sections, but the geographic distribution shows a great concentration in the Western states. California alone accounts for more than a third of the 449 projects while the three Pacific Coast States together have approximately half of the total. Less than 10 per cent of the projects are found east of the Mississippi River. The total capacity of all the licensed plants which have been completed and placed in service now amounts to 2,608,868 hp. This capacity is equivalent to about 24 per cent of all the hydro capacity and slightly less than 6 per cent of the total generating capacity in public utility service throughout the country."

According to the report the end of the year finds "the primary business of the commission in a very satisfactory condition" and "through efforts made during the past year the docket has been practically cleared of applications for large projects contemplating early construction operations." It is stated that recent authorizations will permit the immediate construction of projects costing more than $70,000,000 and that "it is evident that the construction program on these projects will contribute measurably to the stimulation of industrial activities in the localities affected."

The new construction under way is viewed by the commission as "a satisfactory addition to the hydro-electric facilities considering the existing conditions. The ninth annual report out-

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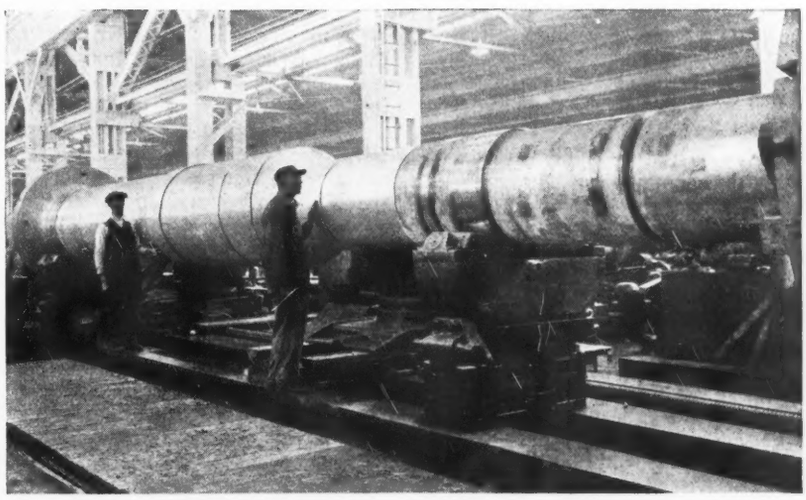
LARGEST HYDRO GENERATOR SHAFT



This immense one-piece steel forging weighing 136,000 lb. and measuring over 36 ft. in length is the world's largest hydro-electric generator shaft, for the Dneiper project in Russia. In addition to transmitting 84,000 hp. this shaft will have a vertical load of 2,000,000 lb. It is here shown set up on a lathe in the Schenectady works of the General Electric Company, where it is being given a semi-finish preparatory to grinding. The coupling shown on the left end of the shaft is nearly 6 ft. in diameter

lined at some length the increasing obstacles faced by new water-power developments and the events of the past year have served only to emphasize the seriousness of these difficulties. The major factor in the situation, of course, consists of the keen competition offered by fuel-generated energy. Even in the regions of abundant water-power resources the steam-electric plant is assuming a position of rapidly increasing importance and demonstrating its capacity to compete on even terms with hydro power. The production statistics for 1929 show for the first time in ten years a failure of the hydro power to record a gain in output. During the same period the energy manufactured by fuel plants increased nearly 10,000,000,000 kw.-hr. Preliminary figures based on records for the first nine months of the calendar year 1930 show that notwithstanding the current business depression the total electric production for the year will practically equal the 1929 output, but the proportion generated from water power promises to be even less than in 1929. This recession in the share of the market served by hydro power is due partly to the widespread and repeated droughts and partly to the trend toward wider adoption of fuel-using facilities."

Regarding reorganization of the commission, the report cites President Hoover's message to Congress a year ago in which the replacement of the cabinet-officer members with full-time commissioners and enlargement of the commission's responsibilities relative to interstate power were recommended. As a result the report states: "Several bills were introduced which aimed to accomplish the reorganization suggested and also to include within the scope of the commission's authority regulatory jurisdiction over certain interstate power transactions. Owing to the complexities of the latter problem, Congress finally restricted the legislation to the reorganization question, and the act was approved by the President on June 23, 1930."

Per Capita Figures Compiled From 1930 Census

Relative to the growing use of electricity, the commission states: "The new census figures have made possible for the first time since 1920 reliable calculations of the per capita production of electricity. These statistics strikingly demonstrate the extent to which all sections of the country are making wider use of electric power. For the country as a whole the per capita demand has more than doubled in the last decade, increasing from 391 kw.-hr. in 1920 to 800 kw.-hr. in 1930. From the standpoint of water-power development, it is significant that in general the regions having the highest per capita consumption are also those in which a large proportion of the energy is generated from water-power sources. This indicates that the availability of low-cost sources of water power has in the past been an important factor in promoting liberal use of electricity. On the other hand, the great rate of increase in per capita use in the other regions during the past decade probably reflects the increasing relative attractiveness of fuel power which has resulted from the marked economies effected in recent years in the production of electricity by the use of fuel. The modern steam station now offers keen competition with the hydro-electric plant, and with the wide distribution of cheap fuel supplies the cost of producing electrical energy has been equalized throughout the country to a considerable extent. It is to be expected that the per capita consumption of power will reflect a similar trend after making allowances, of course, for the heavy uses of large industrial concentrations and the higher cost of serving districts of sparse population."

The report states that 1,104 applications have been filed during the ten years since the passage of the act and that the number and character of those filed during the past year "followed quite closely those of previous years, the proportion of projects of a major type being slightly less than in the preceding fiscal year with a further recession in the total capacity of new applications following the trend which has been in evidence ever since 1926." A total of 133 cases were disposed of during the year as compared with 68 in the preceding year. Also it is stated that as a result of measures adopted during the year for clearing up the delayed cost accounting work on completed projects "the status of the activity has been much improved." Receipts from license fees aggregated nearly half a million dollars representing an increase of nearly 40 per cent over the preceding year.

How's Business?

THERE are enough statistical giblets in this week's records to make a more appetizing sauce for the otherwise dry and lean Thanksgiving turkey this year. Business shows more definite signs of having hit that hardpan resistance level which in the past it has always encountered at about 20 per cent below normal. At this point apparently the elasticity of living standards in this country reaches its limit and fundamental human wants begin to reassert themselves. At any rate our preliminary index, after dipping below 80 per cent has turned up sharply to 81 per cent of normal. Though basic industrial activity is still declining, general trade has begun to expand at somewhat more than the seasonal rate. — *The Business Week,* Dec. 3.

Personals

C. B. Hotchkiss, in charge of the heating and ventilating work in the school of mechanical engineering at Purdue University for the last five years, has tendered his resignation, to become editor of *Heating and Ventilating,* published in New York. Professor Hotchkiss will be succeeded by Prof. W. T. Miller, who has been connected with Purdue for several years.

Lorenz G. Straub, of Kansas City, Mo., who has recently been employed on special studies of the Missouri River, has been appointed to the faculty of the University of Minnesota, where he will have charge of hydraulics. Previously Dr. Straub was in Europe two years making hydraulic studies, as the first Freeman Traveling Fellow of the American Society of Civil Engineers.

W. H. Himes, formerly in the mechanical engineering department of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., has been made manager of the engineering department at the company's Nuttall Works. Other changes in personnel at the Nuttall Works include the appointment of L. R. Botsai, formerly industrial manager of the Central District, as gearing apparatus manager, and the appointment of T. I. Phillips, formerly superintendent of metal stamping at the AB building, as works manager to succeed H. A. Houston, who resigned.

Harry L. Wolf, for the past four years gas engineer for the Shell Oil Company at Ventura, Calif., has been appointed assistant to W. R. Thayer, industrial gas engineer for the Coast Counties Gas & Electric Company, Santa Cruz, Calif.

Ivan Buys, for the past seven years superintendent of transmission of the Kansas Gas & Electric Company, has been appointed chief engineer of the United Power & Light Corporation with headquarters at Abilene. Mr. Buys has had extensive experience in public utility engineering.

A. L. Kimball and J. Ormondroyd have been appointed lecturers on vibration problems at Harvard Engineering School, Cambridge, Mass., where a new course is being given on the mathematics and physics of vibrations in high-speed machines. Mr. Kimball is associate head of the mechanics section of the General Electric Company's research laboratory at Schenectady, N. Y. Mr. Ormondroyd is manager of the experimental engineering division of the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company.

Ross White, formerly superintendent of the Alcoa Power Company, Kenogami, Que., is now with the Dominion Construction Co. at Fraserdale, Ont.

Business Notes

C. H. WHEELER MANUFACTURING COMPANY, Philadelphia, Pa., announces the removal of its New York office to the Woolworth Building, 233 Broadway, New York City. It also announces that after Jan. 1, Thomas B. Whitted, assistant to the vice-president, will be in charge of the New York office. On that date Colonel Whitted, who has long been associated with the activities of the Wheeler company in the Southeast, will sever active connection, except in an advisory capacity, with the Newport News Shipbuilding & Drydock Company. The Wheeler company further announces that Morris B. Carroll has joined its organization and will be attached to the New York office.

HEADQUARTERS OF THE STERLING ENGINE COMPANY, the opening of whose New York office in the Chrysler Building was announced last week in this column, is located in Buffalo, N. Y., not Hyde Park, Mass., as printed in the announcement.

CONSOLIDATED ASHCROFT HANCOCK COMPANY, Bridgeport, Conn., announces the opening of Pacific Coast sales headquarters at 2318 East 8th St., Los Angeles, Calif., with Charles Stepan in charge. Its San Francisco and Seattle agents—Western Engineering Company, 58 Main St., San Francisco, Calif., and Steam Supply & Rubber Company, 308 First Ave., Seattle, Wash.—will continue under the personal direction of Mr. Stepan.

MODERN COAL BURNER COMPANY, Chicago, Ill., announces the opening of two new branch offices. Harvey T. Wharton is in charge of the Minneapolis, Minn., territory, with offices at 720 Baker Building, and L. E. Beckwith is in charge of the Davenport, Iowa, territory, with offices at 509 Kahl Building.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces that because of the present emergency it has decided to place its unemployment relief plan in force this month instead of in January or February as originally announced. Payments, however, will be limited to a maximum of $15 a week to employees needing assistance. Approximately 35,000 employees, from president to office boy, the announcement states, have been contributing to the plan and on Dec. 1 they had paid in $350,000, which with company dollar-for-dollar contributions amounts to $700,000 in the unemployment fund.

THE SHERMAN CORPORATION, business engineers, has recently moved its headquarters from Boston, Mass., to New York City, with branches in Chicago and Toronto. It announces that Austen Bolam has become associated with its research division. For the past four years Mr. Bolam has operated his own business as a consultant in publicity and market research.

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COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. National Fuels Meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Annual meeting at the Mayflower Hotel, Washington, D. C., Jan. 15-17, 1931. Secretary, L. W. Wallace, 26 Jackson Pl., N.W., Washington, D. C.

American Institute of Electrical Engineers. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at the William Penn Hotel, Pittsburgh, Pa., Jan. 26-29, 1931. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

Engineering Institute of Canada. Annual meeting at the Windsor Hotel, Montreal, Que., Feb. 4-6, 1931. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

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Trade Catalogs

VALVES AND CONTROLLERS—Bulletin No. 301 illustrating and describing liquid level controllers, and Bulletin No. 101 on auxiliary operated reducing valves; both issued by the Mason Regulator Company, Dorchester Center Station, Boston, Mass.

STEAM TRAP—Bulletin No. 1030 describing and illustrating the Nicholson industrial steam trap has just been issued by W. H. Nicholson & Company, Wilkes-Barre, Pa.

METERS—Bulletin No. 37 illustrating and describing various types of mechanically operated fluid meters and auxiliary equipment for their installation, has just been published by the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio. Colored meter chart records showing results obtained by the application of these meters to various processes are included, together with sections on orifice and flow-nozzle location, calibration, pulsating flow and special conditions.

INSULATION—Armstrong Cork & Insulation Company, Lancaster, Pa., has recently issued a series of illustrated bulletins on insulating materials, under the following titles: "Nonpareil Insulating Brick for Furnaces, Ovens, Kilns, Boiler Settings and Other High-Temperature Equipment"; "Armstrong's High-Temperature Insulation for Industrial Furnaces"; "The Insulation of Roofs to Prevent Condensation"; "Directions for Applying Armstrong's Cork Covering and Fitting Covers."

GAGES—Bulletin No. 168 illustrating and describing steel-spring recording gages for modern high-temperature and high-pressure installations, The Foxboro Company, Foxboro, Mass.

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Fuel Prices

FUEL OIL

New York—Nov. 28, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.47 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg., $1.695 per bbl.; 32@36 deg., gas oil, 4.026c. per gal.; 38@40 deg., distillate, 4.651c.@4.776c. per gal.

Pittsburgh—Nov. 26, f.o.b. local refinery, 34@36 deg., fuel oil, 3.37½c.@3.75c. per gol.; 36@40 deg., 3.5c.@3.75c.

Philadelphia—Nov. 12, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Nov. 18, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 80c.@90c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—Nov. 24, tank-car lots, f.o.b. 12@14 deg., Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

Dallas—Nov. 22, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.90 @ $2.25
Pool 10, hr.gr. low-vol.	New York	1.75 @ 1.85
Pool 11, low-vol.	New York	1.60 @ 1.75
Smokeless, mine-run	Chicago	1.85 @ 2.25
Smokeless, slack	Chicago	.90 @ 1.25
Harlan, Ky., slack	Chicago	.60 @ .85
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.25 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.30 @ 1.60
Standard Ill., mine-run	St. Louis	1.50
W. Ky., mine-run	Louisville	1.00 @ 1.35
W. Ky., slack	Louisville	.25 @ .50
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.75 @ 2.25
Smokeless, slack	Cincinnati	.75 @ 1.35
Kanawha, mine-run	Cincinnati	1.10 @ 1.35
Kanawha, nut-slack	Cincinnati	.25 @ .75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.50
Barley	New York	1.50

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Conn., New Britain—B. Gundlach, 101 Park Ave., New York, N. Y., is having plans prepared for the construction of an artificial ice plant near Corbin Pl. Estimated cost $40,000. R. B. Engineering Corp., 11 West 42nd St., New York, N. Y., are engineers.

Ga., Augusta—City is having plans prepared for the construction of a complete new power plant. Estimated cost $1,000,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

Ga., Cornelia—Constitutional amendment to allow city to issue bonds for waterworks improvements including filtration plant, pumping station, mains, etc., ratified at Nov. 4th election. Robert & Co., Bona Allen Bldg., Atlanta, are engineers.

Ga., Elberton — City passed constitutional amendment at Nov. 4 election to issue bonds for construction of a hydro-electric plant and dam. R. S. Jandon Engineering Co., Elberton, are engineers.

Ind., Butlerville—Feeble-Minded School, will build a power house at farm for Feeble Minded. Estimated cost $50,000. O. B. Little, 307 North Illinois St., Indianapolis, is engineer. Work will be done by owner's forces. Equipment will be required.

Ky., Louisville — Louisville Water Co., Inc., awarded contract for boilers, superheaters and ash hoppers to Henry Vogt Machine Co., 1000 West Ormsby St.; stokers to Babcock & Wilcox Co., 85 Liberty St., New York; feed water equipment to The Cochrane Corp., Allegheny Ave., Philadelphia, Pa., etc. Total cost $228,487.

La., Crowley—City issued an ordinance calling for the construction of a municipal power and light plant.

La., Crowley—Louisiana Public Utilities Co., Lafayette, is having preliminary plans prepared for the construction of an ice plant here. Estimated cost $50,000.

La., Pineville—Tooke & Reynolds Co., Arcadia, awarded contract for the construction of a power plant and distribution system here to Tudor & Ratcliff, Alexandria. Estimated cost $175,000.

Md., Baltimore—T. Mullan, 3945 Creemount Ave., plans a 10 story apartment building including steam heating system, elevators, etc. at 39th St. and Canterbury Rd. Estimated cost $1,000,000. Owner is builder.

Mass., Holden—City of Worcester, L. Goodale, Water Commissioner, is having preliminary plans prepared for the construction of a pumping station. Estimated cost $40,000. J. Rustigan, 16 Norwich St., Worcester, is architect.

Mass., Newburyport—City, H. W. Little, Clk., is receiving bids for the construction of a boiler house and heating plant, etc., at Plum Island. Estimated cost $40,000 to $50,000.

Mo., Kansas City — Kansas City Power & Light Co., 14th St. and Grand Ave., awarded contract for the construction of a 30 story office building to Swenson Construction Co., Shubert Theatre Bldg. Estimated cost $2,500,000. Owner taking bids now on steam heating system, etc.

N. J., Montclair—Rudgers Builders Supply Co., 101 Greenwood Ave., is having plans prepared for the construction of a 1 and 2 story boiler house, shop, garage, etc. at Greenwood Ave. Estimated cost $150,000. Private plans. Public Service Production Co., 80 Park Pl., Newark, is lessee.

N. J., Newark—St. Barnabas Hospital, J. G. Martin, 685 High St., plans the construction of a hospital, nurses home and power house. Estimated cost $1,500,000. J. H. and W. C. Ely, 605 Broad St., are architects.

Okla., Cushing—City plans an election Dec. 2 to vote $300,000 bonds for the construction of a light and power plant.

Okla., Lawton—City will receive tentative bids Dec. 16 for waterworks improvements including new filtration plant and pumping station, etc. Estimated cost $500,000. F. E. Lawrence, City Hall, is engineer.

Okla., Norman—J. R. Newkumet, is having preliminary plans prepared for the construction of a new ice and ice cream plant. Estimated cost $40,000. Private plans.

Okla., Watonga—City is having plans prepared for the construction of a municipal electric light plant. Estimated cost $100,000. L. Boughton is engineer.

Ore., Portland—Claussen & Claussen, Buyers Bldg., Archts., will receive bids about Jan. 1 for the construction of a 12 story office and stores building including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. at Morrison and 4th St. for Mortgage Investment Co., 365 Yamhill St. Estimated cost $650,000.

Pa., Pittsburgh — U. S. Engineer, Keenan Bldg., will receive bids until Dec. 19 for a hydro-electric plant for Lock No. 8, Allegheny River.

Tex., Schertz—U. S. Government, c/o A. W. Parker, Constructing Quartermaster, San Antonio, awarded contract for the construction of a post exchange building including refrigeration system at Randolph Field, 14 mi. north of San Antonio to R. E. McKee, El Paso. $41,700.

Utah, Mount Pleasant—City Council, will receive bids until Dec. 6 for the construction of a 200 hp. municipal hydro-electric plant, including pipe, waterwheel and electrical equipment. Caldwell & Richards, Templeton Bldg., Salt Lake City, are engineers.

Wis., Two Rivers—City plans the construction of a new power plant. Estimated cost $40,000. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

Equipment Wanted

Air Compressor—Granite City, Ill.—H. Watson, 1710 State St., plans to purchase a medium sized air compressor.

Filtration Equipment, Switching Equipment, Transformers—Niagara Falls, Ont.—Bd. of Water Commissioners, will receive bids until Dec. 20 for filtration equipment, switching equipment and low tension step down transformers at new waterworks filtration plant. Estimated cost $50,000.

Motor—Blackwell, Okla.—City will receive bids until Dec. 18 for a 50 hp. motor direct connected to a centrifugal boiler feed pump for waterworks.

Motor—Montreal, Que.—Scrutan Co. of Canada Ltd., 3081 Ontario St. E., plans to purchase a 5 hp. electric motor.

Motors, Transformers, etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Dec. 10 for electric motors, transformers, etc.

Pump—Beverly Hills, Calif.—City, B. J. Firminger, Clk., will receive bids until Dec. 2 for one deep well turbine pump for waterworks.

Pump—San Francisco, Calif.—City is making specifications for an electrically driven centrifugal pump with appurtenances for Mills Field Municipal Airport.

Pump, Etc.—Clarkton, Mo.—City will soon receive bids for a vertical turbine pump, etc. for proposed waterworks system. Estimated cost $20,000.

Pump and Motor—Natrona, Pa.—Commissioners of Harrison Township, Town Hall, 41 Chestnut St., will receive bids until Dec. 10 for a 500 g.p.m. vertical shaft centrifugal nonclogging pump and motor for proposed sewage treatment work near here.

Pumping Equipment — Columbus, O. — War Dept., Washington, D. C., pumping equipment for proposed 10 in. water well at Columbus General Depot here.

Pumping Equipment, etc.—Alexandria, Ont.—Town plans to purchase centrifugal pumping equipment, etc., for proposed extension to waterworks system. Estimated cost $20,000.

Pumping Units, Switchboard, etc. — Tulsa, Okla.—City will receive bids until Dec. 9 for three 12 m.g.d. low service motor driven centrifugal pumping units with priming units; switchboard and wiring connections ... proposed waterworks pumping station.

Pumps—Redwood City, Calif.—City plans to purchase two 400, two 500 and one 140 g.p.m. pumps for proposed sewage treatment work. $146,000.

Pumps and Motors—Coraopolis, Pa.—Borough of Coraopolis, Municipal Bldg., W. E. Cain, Secy., will receive bids until Dec. 12 for two booster water pumps and two motors.

Switching and Transforming Equipment — Woodstock, Ont.—Hydro-Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the installation of duplicate switching and transforming equipment in Woodstock sub-station here. Estimated cost $350,000. Work will be done by day labor.

Industrial Projects

Calif., Emeryville—Westinghouse Electric & Mfg. Co., awarded contract for the construction of a 1 story addition to factory on Powell St. to Cahill Bros., 206 Sansome St., San Francisco. Estimated cost $40,000.

Calif., Los Angeles—Overland Terminal Warehouse Co., awarded contract for a 6 story, 100 x 620 ft. warehouse, including cold storage facilities, loading platforms, etc., at Ninth and Alameda Sts., to J. V. McNeil Co., 5860 Avalon Blvd., Los Angeles. Estimated cost $1,000,000.

Conn., Bristol—Bristol Co., S. R. Bristol, Waterbury, plans addition and alterations to factory on Platts Mills. Estimated cast $50,000. E. A. Webster, 51 West Main St., Waterbury, is architect.

Conn., Fairfield—McKesson & Robbins, Inc., Grasere St., had plans prepared for addition to factory. Estimated cost $100,000. Fletcher Thompson Inc., 1336 Fairfield Ave., Bridgeport, Archts.

Md., Baltimore—Canton Co., Canton House, awarded contract for the construction of a 2 story pier, freight and passenger shed at Pier 10 to Sanford & Brooks Co., Canton House. Estimated cost $500,000. Baltimore-Hamburg Co. is lessee. Steam heating system, loading and unloading equipment, etc., will be installed.

Mass., Malden—(Boston P. O.) E. J. Lamothe Co., 25 Chestnut St., Somerville, awarded contract for a 1 story, 100 x 140 ft. factory at Willis Ave. and Green St. to R. J. Gauvreau & Co., 11 Beacon St., Boston. Estimated cost $50,000.

N. J., Newark — J. C. Kohaut, Inc., 117 Green St., rejected bids for 3 story, 50 x 100 ft. woodworking factory on New York Ave. Estimated cost $40,000. M. N. Shoemaker, 10 Bleecker St., is architect.

N. Y., Port Ivory—Procter & Gamble Co., 17 Battery Pl., New York, awarded contract for the construction of a 1 story addition to boiler house here to P. M. Sterling, 230 Park Ave., New York. Estimated cost $40,000.

N. Y., Stapleton—Rubsam & Horrman Brewing Co., 191 Canal St., will soon award contract for a brewery, ice manufacturing and storage building. Estimated cost $300,000.

O., Youngstown—Youngstown Sanitary Milk Co., 715 Erie St., will soon award contract for a 1 and 2 story, 43 x 121 ft. dairy plant, and 30 x 55 ft. power plant. Estimated cost $100,000. Braziell & Anderson, 309 Fowill Ave., Pittsburgh, Pa., are architects.

Okla., Chickasha—Chickasha Cotton Oil Co., plans the construction of a 3 story, 77 x 142 ft. refinery. Estimated cost $50,000. E. H. Eods & Co., Hall-Briscoe Bldg., are architects.

Okla., Chickasha — Southwestern Light & Power Co., Braniff Bldg., Oklahoma City, is having preliminary plans prepared for the construction of a natural gas compressor station near here. Estimated cost $40,000. Private plans.

Oklahoma — Bird Aircraft Corp., 17 Haverkamp St., Glendale, L. I., N. Y., plans the construction of an aircraft manufacturing plant at Oklahoma City or Tulsa. Estimated cost to exceed $40,000.

Pennsylvania—Sun Oil Co., W. A. Courtney, Engr., Sun Bldg., Philadelphia, awarded contracts for bulk plants, including warehouses, offices and pump houses at Altoona and Brownsville; also plant to include oil and pump house, separate boiler house addition, etc., at Greensburg to Hughes-Fouldrod Co., Schaff Bldg., Philadelphia.

Pa., Baden—Pennsylvania R.R., Broad St. Station, Philadelphia, is receiving bids for masonry, machinery and equipment for river rail terminal to be used mainly in transportation of coal, on Ohio River near east end of Conway yards here. Estimated cost $350,000. T. J. Skillman, Philadelphia, is chief engineer.

Pa., Hannastown—Jamison Coal & Coke Co., R. E. Jamison, Secy., Main St., Greensburg, awarded contract for the construction of a coal cleaning plant including conveyors and complete washing equipment in Westmoreland County to Fairmont Mining Machinery Co., Fairmont, W. Va.

B. C., New Westminster—Bloedel Stewart & Welch, plans to rebuild shingle mills and dry kilns recently destroyed by fire. Loss $250,000. Complete equipment will be required.